Water
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Published Quarterly Vol. 9, No. 4 Fall 1977

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Comments on topics in this publication are invited. Send to:
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Washington, D.C. 20314

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Use of funds for printing this quarterly publication was approved by the Director of the Office of Management and Budget through June 30, 1978.

A major purpose of this publication is to serve as a written forum for the open discussion of issues and choices in resolving water resource problems. Views and conclusions expressed or implied do not necessarily reflect the position of the Corps of Engineers.

Subscription rate is $6.20 per year; $1.55 additional for foreign mailing. Price of a single copy is $1.55. Order directly from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

This issue developed by Office of Staffing and Management, Directorate of Civil Works.

Address changes: Please attach old address label to request for changes.

COVER: In their competition with man for natural resources, other species are sometimes big losers. In a continuing series of articles on this modern dilemma, Water Spectrum *in this issue discusses the precarious existence of some plants. Problems of amphibians and reptiles will be examined in the upcoming Winter issue. See page 20. Photo by C. Kenneth Dodd, Jr.*

Mitigating Measures

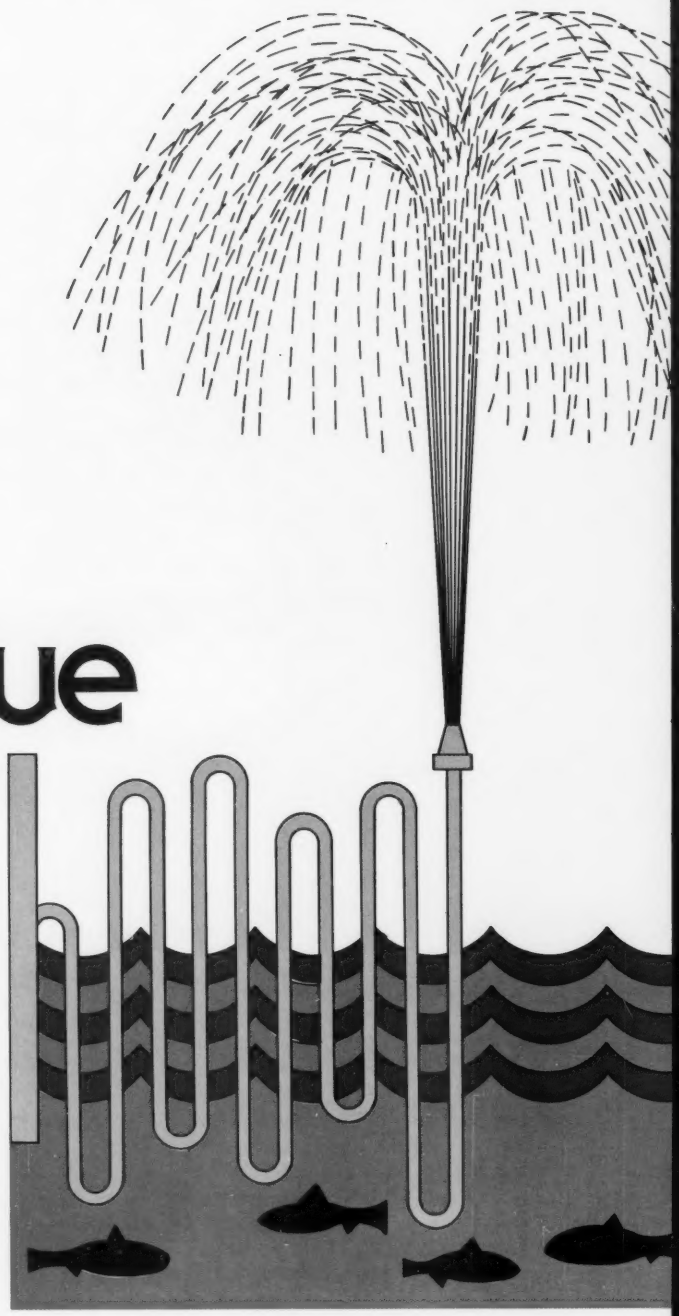
Over the past few years, a number of dams have been built on rivers of the Pacific Northwest for hydroelectric generation, water supply and other purposes. When low water levels occur during the critical migration and spawning seasons of the Chinook salmon and steelhead trout, the dams have caused high mortality rates among these valuable fish.

Programs to save the fingerlings were started in 1968. When it became apparent that 1977 would be a year of severe drought, however, the Corps of Engineers, in cooperation with other agencies, began extraordinary efforts to avert the disastrous losses that would surely come.

The following accounts describe their unique actions along the Columbia, Snake and Rogue Rivers.

Sprinkling on The Rogue

by **Edward B. Johnson**



"Away we go" echoed across the canyon in the upper reaches of the river made world-famous by Zane Grey. A huge crane swung a 65-ton gate into place, permanently sealing the diversion tunnel at Lost Creek Dam and began storing much needed water behind the 345-foot high earth fill dam for the parched Rogue River Basin in southern Oregon.

Friday morning, February 18, 1977, was the milestone date. An earlier closure of Lost Creek scheduled for February 3, had been postponed by Oregon Governor Bob Straub and members of the Oregon congressional delegation. Biologists had last minute fears that despite the precautionary measures already taken, closure might result in a significant loss to the nationally famous fishery resources of the Rogue River.

The fishery experts were concerned that water receding below the dam after the diversion tunnel was closed might leave salmon eggs and fry (newly hatched salmon) high and dry. State officials studied these concerns as well as the benefits to be obtained by filling Lost Creek reservoir in a drought year; and, after reviewing the alternatives, Governor Straub withdrew his request to postpone and agreed closure should take place.

The countdown began as bus and carloads of school children and interested spectators from surrounding communities lined the hills overlooking the river. Local boosters sent red, white and blue balloons aloft, and newsmen with TV cameras clambered over the slopes for closeups of the gate slowly being lowered to seal off the diversion tunnel. As it settled into place, the mammoth gate all but halted the flow of the Rogue River, and within moments the backed-up waters began to creep up the steep rock walls directly behind the diversion tunnel.

Downstream, even before the river's flow slowed and decreased, an ingenious arrangement of pipes and sprinklers reaching out from the riverbanks began to spray the shallows and pebble-dotted flats of the streambed.

Mr. Johnson is Chief of the Environmental Resources Branch for the Portland District of the Corps of Engineers and is presently serving the District on a rotation assignment as the Rogue River Basin Coordinator.

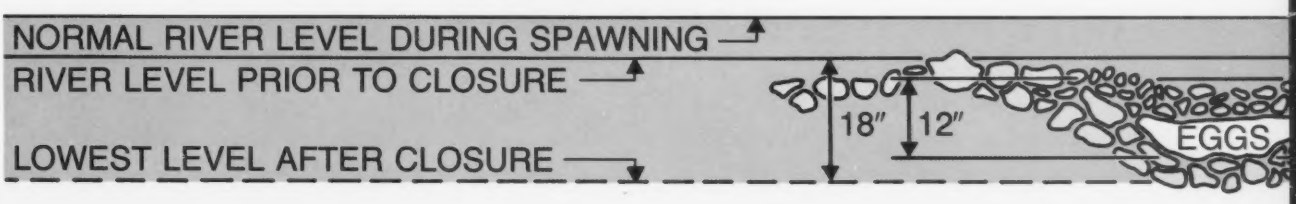
Aerial view shows Lost Creek Dam, the curved structure near the water intake tower. Large cleared area behind the dam is now Lost Creek Lake. Cole M. Rivers Fish Hatchery, largest in Oregon, is located between the spillway and a small reregulation dam.

Why sprinklers wetting down a river? This fish story begins when Lost Creek Dam was still under construction. In September 1974 the Portland District of the Corps of Engineers entered into a cooperative agreement with the Oregon Department of Fish and Wildlife for long-term research on the effects that impounding the waters of Lost Creek Lake would have on salmon and steelhead trout. Important facets of the 9-year Rogue fishery study include life history, physiology, hatchery propagation and the influence of changes in water temperature and turbidity.

The soon to be filled reservoir would increase summer flows in the Rogue River and reduce high water temperatures by storing winter and spring runoff which would be released in the warmer months. These changes to existing flow and temperature patterns could affect certain phases of salmon and steelhead life patterns such as migration, spawning and freshwater growth of the juvenile fish. The study was designed to compare before and after impoundment river conditions and their effects on salmon and steelhead life cycles.

An important part of the ongoing study is an evaluation of operational procedures for Cole M. Rivers Fish Hatchery located below the project. The $7-million hatchery, the largest in Oregon, was built by the Corps of Engineers to mitigate the loss of upstream spawning areas. Hundreds of thousands of young Chinook salmon and steelhead trout are being produced at the hatchery every year. Ideally, these hatchery fish would migrate directly to the Pacific Ocean after release and not compete for the natural food supply. However, an abundance of these fish remaining for very long in the river could compete with wild fish already present. To help achieve immediate migration to the ocean, experiments are being conducted to identify the time of release and physical and physiological criteria that determine when the hatchery fish are ready to migrate.

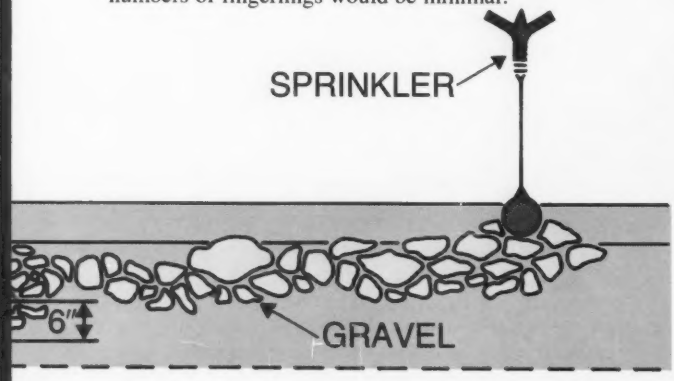
Salmon Redd Protection
U/S of Big Butte Cr.



One of the major difficulties to be overcome on the Rogue River is the extreme heat in the lower canyon during the summer. Water temperatures sometimes reach nearly 80 degrees—too warm for fish to survive. To help migrating fish by cooling downstream flows to 68 degrees, a special water control structure was needed that would regulate temperatures of released downstream water.

Corps designers developed plans for an intake tower, one of the first of its kind, that would draw water from various depths of the lake, combine it in a mixing chamber, and release it downstream at differing temperatures. Information learned from the research is being used to develop a plan to control temperatures and flows and improve environmental conditions for the fish.

As the studies progressed and construction of Lost Creek Dam neared completion, an immediate problem arose. During the first stages of construction, an April 1976 deadline to fill Lost Creek Lake had been proposed by the Corps. Closure in April would reduce the river flow from 2,000 to 400 cubic feet per second in less than 2 hours as the river squeezed through an 8-inch wide opening in the closure gate. This would cause a marked reduction in the water level immediately downstream, exposing the eggs and fry to warming, drying and oxygen reduction. The stretch of river primarily affected would have been the first several miles below the Lost Creek project where Chinook salmon migrating upriver would be heavily concentrated. In addition, agencies also feared the potential storage of muddy spring waters and that fingerlings in the area might be stranded. In evaluating the information on flow stage reduction elsewhere, they estimated that losses would be least in the fall when the numbers of fingerlings would be minimal.



Biologists were also concerned that impoundment of relatively warm spring and summer inflows following an April closure would result in warm releases from the reservoir in the fall, especially if unusually low flows were to yield a partially filled, shallow reservoir susceptible to warming by the hot Rogue Valley sun.

Spring Chinook generally spawn in September and October in the Rogue, with peak spawning in late September. Since average September water temperatures in the upper reaches of the river range from about 50°F-53°F, any significant warming caused by impoundment could cause temperatures downstream to exceed the 41°F-58°F range of optimum temperatures for survival of eggs and sac fry. The intake tower designed to cool the downstream water was operational in time to solve the problem of warm releases. It proved to be completely effective.

The Corps also studied the agencies' request to modify the closure gate to include additional or larger openings, in order to provide greater flow when the tunnel was closed. However, it was not practical in the time available to redesign and reconstruct the gate which had already been fabricated and stored on the project.

After weighing potential losses to the fishery resource against other factors, we decided that fall closure would be justified. Schedules were revised accordingly, with particular concern for the magnitude and unique nature of the Rogue fishery resource.

During deliberations by the Corps and the fish agencies, a lawsuit regarding a similar situation elsewhere drew the immediate attention of everyone

Sprinklers are irrigating Rogue River salmon spawning beds, downstream of Lost Creek Dam.

concerned. A hearing was being convened to fix responsibility for a huge fish kill on the Columbia River where more than a million salmon fry were alleged to have been destroyed during a low flow test.

The river, lowered for surveys of water-intake structures for a nuclear power plant near Hanford, Washington, had not been returned to its previous level before the large kill of salmon fry had taken place. Caution became the watchword as agency representatives pondered the possibility of a similar problem at Lost Creek.

As the engineers and biologists knew, Chinook salmon, the largest and hardest fighting fish in the river, have rigid requirements for spawning. They dredge out pockets in the gravel by a fanning motion with their tails and the hydraulic assistance of the river current. The eggs are deposited in the gravel nests that are 8 inches to as much as a foot and a half deep. By dredging upstream from the "redd" or next pocket, the salmon covers the eggs with gravel with the help of the current.

When water circulates through the protective gravel, it brings oxygen to the eggs. After hatching, the young "sac fry" are nourished by their yolk sacs, remaining in the gravel until they are ready to emerge into the stream and begin feeding. The major job facing the Corps would be protecting the eggs and early fry.

After numerous meetings and extensive coordination of methods for protecting eggs and fry, the Corps suggested

The major job facing the Corps was protecting the salmon eggs and early fry when the dam was closed to fill Lost Creek Lake.

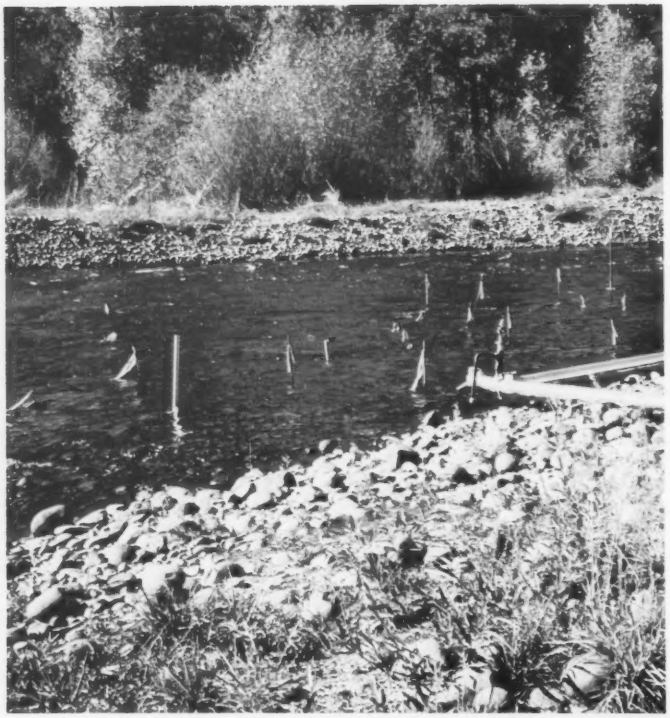
an innovative approach involving a system of pipes, nozzles, impulse sprinkler heads and pumps to keep redds wet and reduce water temperatures, thereby keeping salmon fry and eggs alive in the river gravels. As far as anyone knew, such a system had never been tried before. All agencies agreed to go ahead.

More coordination meetings were held. Details of a plan were put together covering logistics, equipment, manpower requirements, siting of equipment and sequence of events. A specially designed sprinkler system was set in place at six locations where the 2,000 or more salmon redds were concentrated. Marker flags were placed along study transects and a monitoring program was implemented.

A private power company operating on a tributary agreed to shut down a power plant diversion to provide extra water needed downstream during the closure. Sometime between October 15 and December 1 was selected for closure, as this season brings rain, cool air temperatures and rising tributary inflows which would help to protect the young salmon.

With the onset of October, all was in readiness and the agencies waited for the best conditions. November, December and January passed but still the rains did not come. In fact, the drought was proclaimed the worst in history. As winter wore on, a new element complicated matters—Chinook salmon fry began to emerge from the gravel and steelhead began to move into this reach of the river to spawn. We had to close soon or wait till the next fall. The decision was made to close.

Salmon dig redds or nest pockets in the gravel by fanning their tails, assisted by the river current.



Specially designed sprinkler system was set in place at six locations where the 2,000 or more salmon redds were concentrated. Red flags mark locations of the nest pockets.

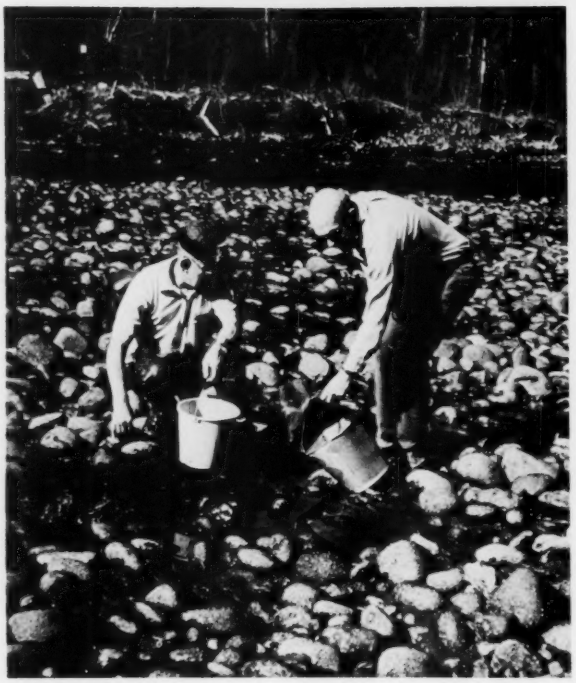
When the huge crane began to move on that February morning, all systems downstream were "go." About 40 people from the Corps and fishery agencies were deployed to sample redds, move sprinklers for more effective coverage where necessary, rescue stranded fish, and monitor the results. Members of the Rogue River Guides Association, the Rogue Flyfishers, Izaak Walton League, Sierra Club and individual sportsmen and environmentalists assisted and were credited with saving hundreds of small fish, mostly year-old steelhead that were left behind by the receding waters.

Two weeks later, a report on the effects of closing Lost Creek Lake was jointly released by the Corps and the fishery agencies. There was no significant mortality among the spring Chinook eggs and fry in the gravel spawning beds, and stranding of fingerling did not result in significant mortality.

The report emphasized that the unprecedented sprinkling of the spawning gravels, had made the difference. The natural spongelike characteristics of the silty gravel bars that held the water had enabled the sprinkler system to be used successfully. The cooperative project was a success, and everyone was pleased with the results.

The needs for fish preservation had been met; the stored water would fill many human needs later in the year should the drought continue; and enhancement flows would be provided for the salmon in the late summer months. Thus a situation that had the potential for disaster resulted in a harmonious and innovative solution; one that would be helpful to others faced with a similar problem in the future.

Corps and fishery agency employees, along with volunteers from environmental and sportsmen groups, worked to save the fish stranded by receding waters.



Operation Fish Run

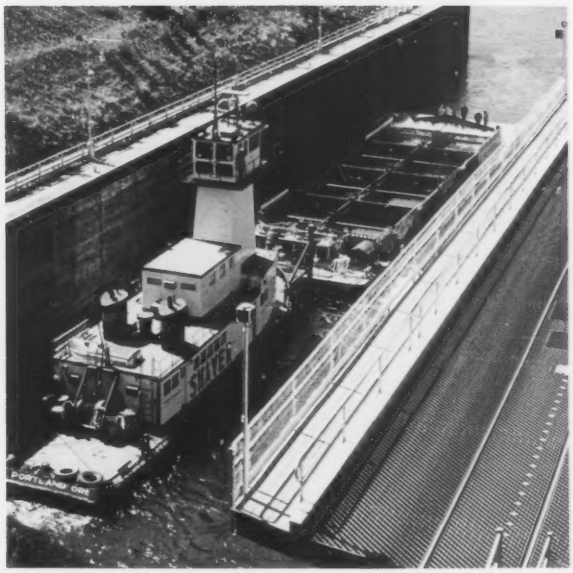
by **Frank King**

Every spring, high in the tributaries of Northwest rivers, an amazing natural drama unfolds as millions of young steelhead trout and chinook salmon begin their downstream exodus to the sea. The spring freshet originating from snow packs and glaciers in the high mountains of the Pacific Northwest normally carries the small fish to the ocean—at one time a journey of a week or two. When there is no spring freshet, the young fish must swim downstream. Those coming down the Snake and lower Columbia Rivers must pass through eight dams, while the juveniles coming from the Okanogan and other tributaries have to travel through as many as nine dams. Their trip of several hundred miles to the estuary where the Columbia meets the Pacific Ocean takes up to a month or longer since the dams were built.

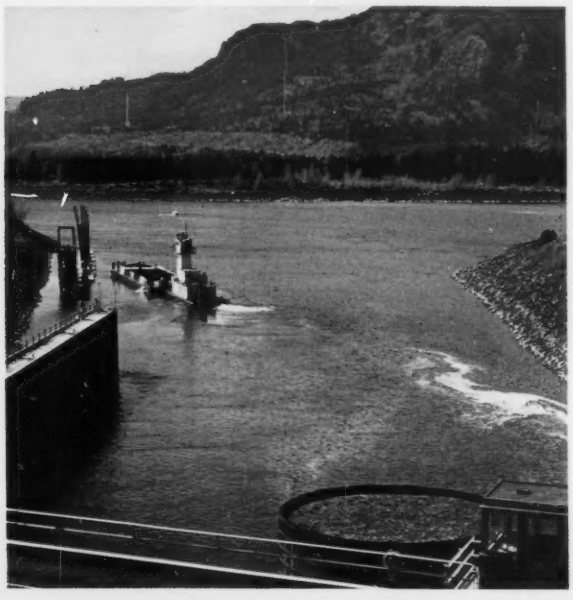
In high water years, many of the 4 to 10-inch fish are passed over the dams' spillways in the excess water not needed for electrical generation.

Low water years have been notoriously hard on juveniles migrating downstream. During these times, the salmon and steelhead trout can get through the dams only by entering the penstocks and going through the giant turbines where mortality is high. About 11 percent of the small fish are killed at each dam. Additional numbers are lost to bird and fish predators below each project.

This year a drought has struck the Pacific Northwest that promises to be the worst on record. Because of mitigation efforts of the past few years and special programs this year, however, most of the 8 million fingerlings running to the sea have been saved.



Specially adapted barge, loaded with up to a million young fish, is leaving Bonneville lock and dam for its release site, 4 miles downriver.



Operation Fish Run I began in 1971 when the Corps of Engineers became involved in a substantial way in transporting juvenile salmon and trout around the dams on the Snake and Columbia Rivers. The first transportation

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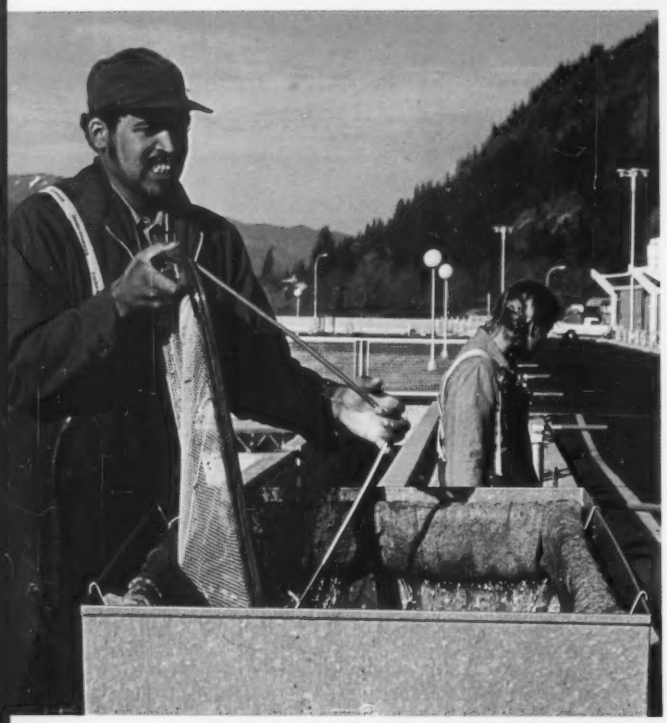
efforts, however, actually began in 1968 when the National Marine Fisheries Service—then called the Bureau of Commercial Fisheries—began dip netting juvenile salmon from turbine intake gatewells at Ice Harbor Dam. They placed them in specially designed tank trucks and released them into the river, some just below John Day Dam and others just below Bonneville.

The Service found that trucking fish reduces mortalities caused by both nitrogen supersaturation and the fingerlings passage through the turbines. It also cuts down losses to natural predators such as squawfish and sea gulls.

This early pilot program showed that small fish could be trucked around the dams and still retain their homing instincts. Early studies found that direct transportation fatalities averaged less than 1 percent and the returned rate was excellent. Up to 20 times more transported fish survived to return as adults than those which migrated naturally down through the dams.

A number of modifications were developed at the dams before the initial program was begun. In the early '60s, for instance, some juvenile downstream migrants were observed in the large gate slots in the dams' turbine intakes. They apparently fled there to escape increasing pressure as they were drawn down into the turbines. A fingerling bypass system was constructed at John Day Dam, which was completed in 1968, and at all Corps dams completed on the Snake River after 1968. This system

Fingerlings are being dipped out of holding area at Spring Creek National Fish Hatchery in Washington. A worker loads the young fish into gravity flow line which takes them to the waiting barge. Mount Hood rises above the trees behind the vessel.



allows the small fish to get out of the gatewells near the water surface, be carried around the turbines, and then to be returned to the river below the dam. Similar bypasses were added to the rest of the dams, and by 1975 each of the Corps projects on the lower Snake and Columbia had some type of operating system.

Another of the modifications, a traveling screen, is used with the bypass system to facilitate the collection of juveniles for transport. Initially developed at Ice Harbor Dam, by spring 1971 the original screen and two others constructed by the Corps in consultation with the National Marine Fisheries Service were placed in service for testing. Little Goose, the uppermost dam on the lower Snake River at that time, was chosen as the test site. The screens were installed in the three gatewell slots of one turbine where they diverted most of the downstream migrants from penstocks into gatewells. The discharge end of the bypass from the gatewells was modified to carry fish to an onshore facility where the fish could be collected for truck transportation.

Extensive research and development has been carried out by the Corps in consultation with the National Marine Fisheries Service since 1971 to improve fish transportation. More and better traveling screens were designed, constructed and installed, and additional tank trucks were acquired.

In addition, the Corps has contracted two 6-year research programs with the National Marine Fisheries Service. In the first, statistically significant transport groups were marked each year and were observed for 3-year periods. Adult returns were evaluated for 3 additional years. The second 6-year research program was begun in 1975, when Lower Granite Dam was completed,

Migrating salmon and trout have been trucked around the eight dams on the Snake and lower Columbia Rivers since 1968. Chinook salmon are being piped onto a barge near Kooskia, Idaho in this year's record drought.

to evaluate transportation from and returns to Lower Granite, which is now the uppermost dam of the Snake River series.

These studies have verified that as many as 80 percent of the fish entering the turbine areas can be diverted into the bypass systems by traveling screens. Adult returns for certain runs of fish have been as high as 23 transported fish to every one not transported.

Because of these good test results and the extremely low survival rate of nontransported fish in 1973, the Corps reached an agreement with State and Federal fishery agencies to increase the numbers of fish transported. In 1975 and 1976 a mass transport program was carried out—as many fish as could be collected were trucked around the dams. As of 1977, all three turbines at Lower Granite and two turbines at Little Goose have been screened.

The extremely low waters of this record drought year soon made it apparent that all river flows would be passing through the turbines and no spillage would occur. This meant that all the juveniles would be passing through the turbines of the dams on the Columbia and Snake Rivers. During the peak of the migration, approximately 40 percent of an estimated 8 million fingerlings would arrive at Lower Granite and Little Goose within a 5-day period. This number would exceed the hauling capacity of the eight specially designed tank trucks on hand.

Operation Fish Run II was launched to cope with the problems of the '77 drought. The Corps adapted barges, pushed by a river tug, to handle these excess numbers of out-migrating fish. In consultation with the National Marine Fisheries Service and other fishery agencies, the Corps designed, contracted and completed two barges in 6 weeks.

The barges were leased from a private company that had used them to haul sulfite liquor waste for a paper company. They had to be carefully prepared by the Portland company that modified them. All critical surfaces coming into contact with or affecting the fish culture water had to be sandblasted. Six diesel-powered pumps were leased to provide circulation water for the fishways; each can pump 3,000 gallons per minute. Installed three to a barge, only one or two operated at a time and one was on standby.

Two Corps employees, Edward M. Mains and Hugh A. Smith, served as godparents and midwives to the newborn operation. Ed Mains explained: "The barges are really floating fish culture stations. We put two fish hatchery raceways in each barge. The water system on the barges can be operated in two different modes. Normally we use regular river water pumped through the barges to provide good oxygenated water for the fish. But, if we run into pollution problems, we can shut off the river flow and go into a closed system. Pressurized oxygen tanks on the barges provide oxygen and water is recirculated by pumps. After the pollution area is passed, we can again go back to using water directly from the river."

Named "Brian" and "Duke" after the young mechanical design engineers who did most of the design work, the barges can each safely transport 350,000

steelhead smolts or 500,000 to 1,000,000 juvenile chinook salmon. A tanker truck can handle 25,000 to 30,000 of the same fish species on the 400-mile trip past the dams.

In addition to the eight trucks and two barges, a World War II PBY (Flying Boat) was used on an experimental basis again this year. The airplane can make the trip to Bonneville much faster, but the payload is much lower. Time for the trip downriver with the barge and tug is about 36 hours; the truck run takes 8 hours; and flying time for the PBY is 1½ hours.

At a cost of $784,600, this year's Operation Fish Run collected and transported nearly two-thirds as many fingerlings as were moved from Little Goose and Lower Granite in the preceding 6-year period. In the low water year of 1973, only 3 percent of the run was trapped at Little Goose Dam. In 1975 this small number accounted for 40 percent of the adults migrating upstream to spawn.

This year's tallies show 1,373,000 chinook and 905,505 steelhead were transported from the two collection sites. Coho salmon as well as spring, summer and fall chinook and steelhead from fish hatcheries along both the Snake and Columbia Rivers were also moved this spring by Operation Fish Run barges. The hatchery numbers boosted the total hauled to 5,417,000.

Operation Fish Flow '77

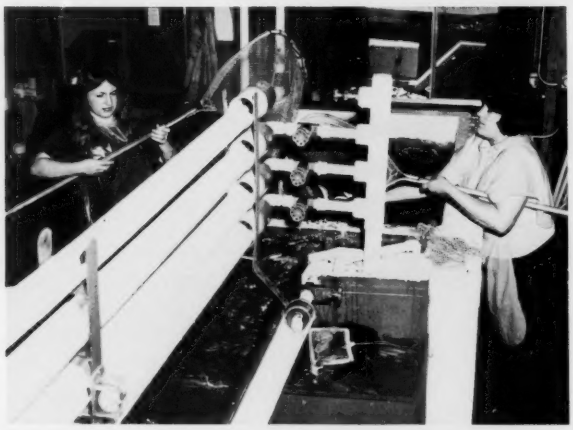
An additional effort was necessary because there was no way to trap downstream migrants when they arrived at the mid-Columbia dams belonging to the public utility districts. In this drought year, downstream migrants would have to pass through turbines at as many as five public utility dams. Downriver, the McNary, John Day, The Dalles and Bonneville Dams have fingerling bypass facilities but no deflector screens and mortalities would have been somewhat less.

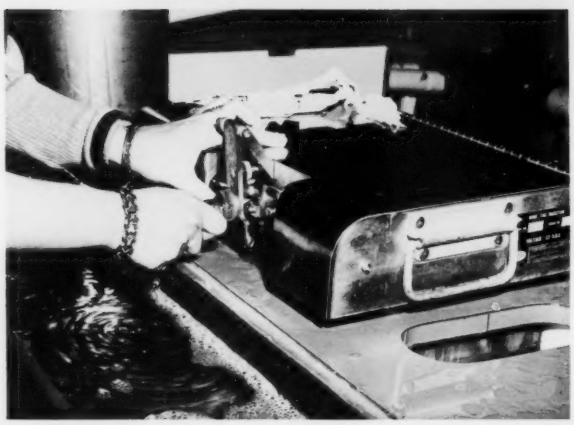
The companion program, Operation Fish Flow '77, was a joint operation coordinated through the Corps of Engineers, the Bonneville Power Administration, the Bureau of Reclamation and the National Marine Fisheries Service. Federal and non-Federal reservior operators and Federal and State fish and wildlife agencies participated.

The operation was planned to insure that the fish would indeed migrate and not become reservoir residents. An artificial freshet was created with water released from upstream storage reservoirs to provide augmented flows.

The Columbia River Power System was adjusted by altering maintenance schedules and exchanging power within and outside the region to minimize loss of energy.

A 6-year research program has been carried out to determine survival and return rates of the juveniles. Liquid nitrogen, which never disappears, is being sprayed on the side of the fish. Another marking method uses a machine that injects a tiny magnetic sliver into the fingerling's nose. The wire will trip a trap when the adult migrates upriver in 2 or 3 years. About 10 percent of the fish are marked.





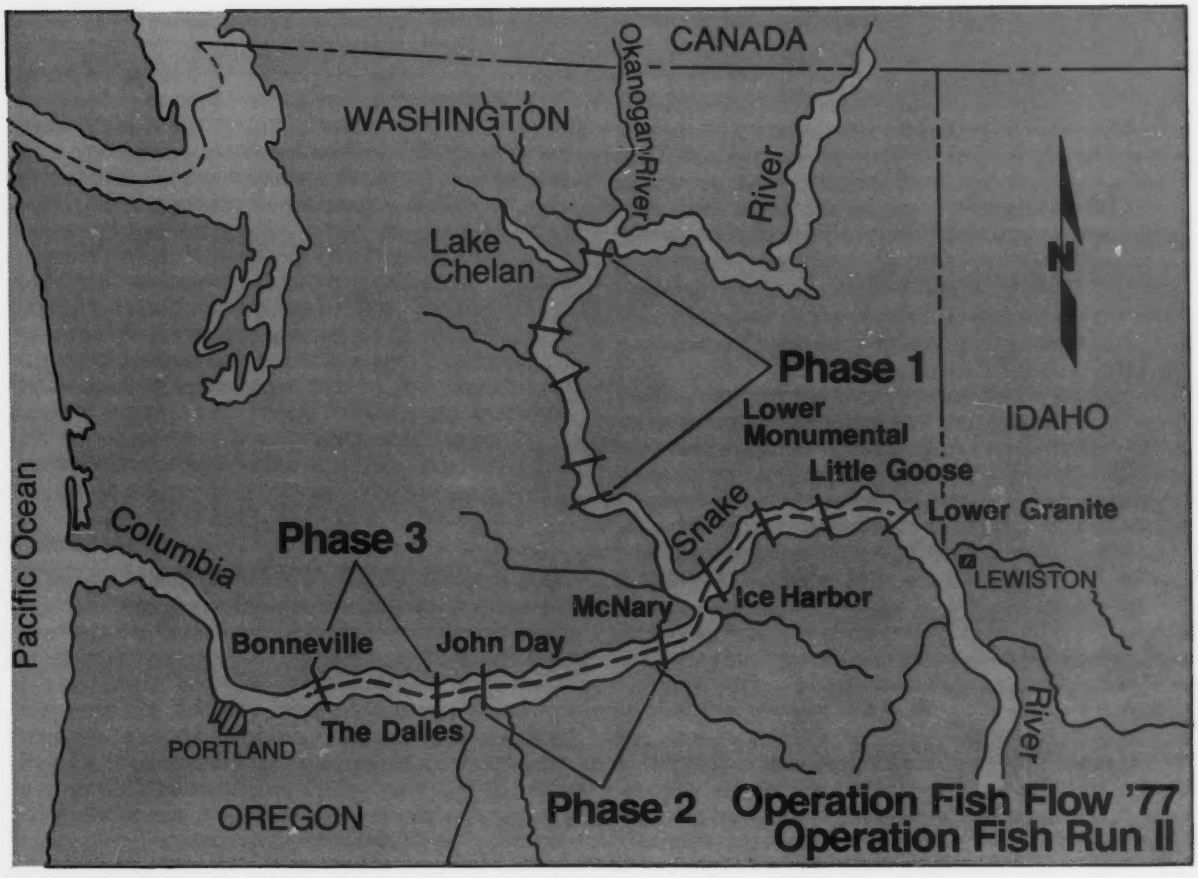
Water flowed over the dams' spillways for several hours a day to ensure that some of the fish safely bypassed the turbines. The entire regulation period lasted for the 6 weeks of the run, with Phase I augmenting the flow at the utility dams, Phase II taking place at McNary and John Day, and Phase III supplementing the flow at The Dalles and Bonneville Dams. The released storage combined with natural flows provided average weekly flows of 100,000 cubic feet per second in reaches of the mid-Columbia and as much as 180,000 cubic feet per second in the lower river. Biologists from the Corps, the National Marine Fisheries Service, the Washington Departments of Fisheries and Game, and the three county public utility districts were on continuous duty at each of the dams to monitor the progress of the run.

"We figured," said Ed Mains, "that if no dams participated in Fish Flow '77 only about 1 percent of the Columbia River run would get below Bonneville. If only the four Corps dams participated, 6 percent of the run would have survived. With all nine dams participating in the effort, we estimated 15 to 20 percent of the run would reach the ocean to mature. This compares favorably with survival under average flow conditions."

According to Howard Raymond of the National Marine Fisheries Service, preliminary reports indicate 28 percent of the fish migrating down the mid-Columbia survived. He attributed their survival to Operation Fish Run II and Operation Fish Flow. "If nothing had been done, there would have been a complete disaster."

The record low rainfall of 1977, the low river flows and the drought in the Pacific Northwest will go into the history books. It is a natural disaster that is touching almost every phase of life in the area. Fish and wildlife in particular are being affected; but the Corps, other cooperating Federal and State agencies and the public utilities are working together to ensure that the salmon and steelhead in the Columbia River system will survive their annual runs to the sea. ■

The dashed line shows the route the Operation Fish Run II barges followed. The airplane followed the same general route and the runs traveled on roads paralleling the rivers. Wells, Rocky Reach, Rock Island, Wanapum and Priest Rapids Dams are Public Utility District facilities on the upper Columbia. The two dams just above those five are Chief Joseph and Grand Coulee. They do not have fish ladders so the Columbia runs of salmonids come from tributary streams such as the Wenatchee and Okanogen. Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville are Corps dams. Chief Joseph, on the upper Columbia is a Corps facility and Grand Coulee is a U.S. Bureau of Reclamation dam.



Braunschweig: A Cooperative Success

by **Erick Schaerff**

A group of farmers and city representatives, assisted by the State, formed an unusual association in 1954 in central Germany. Through their alliance, members hoped to solve the twin problems of treating the growing city's wastewaters at a reasonable cost and irrigating and fertilizing agricultural land that could produce only minimal harvests. During its 23 years of existence, this farm-city cooperative has largely achieved both goals, overcoming a number of difficulties to develop one of the world's finest land treatment systems.

The Braunschweig Sewage Utilization Association had some local experience upon which to build. As early as 1936, wastewaters from the nearby city of Wolfsburg and a volkswagen factory were being sprayed on farm lands. The regional plan at that time called for installation of a similar spray irrigation system using wastewaters from Braunschweig and the city of Salzgitter-Lebenstedt. World War II halted planning and construction for many years, however, and Salzgitter-Lebenstedt eventually built a traditional sewage treatment plant. The idea of purifying wastewater in the ground and simultaneously reusing it for farming persisted in Braunschweig, perhaps because the city had since 1896 been filtering wastewater through soil by intermittently flooding selected fields.

The reasonable costs of land treatment systems, along with these successful examples of wastewater purification by irrigation, led to the founding of the cooperative.

The Organization

The 3,000 hectares[1] irrigated by the Braunschweig Sewage Utilization Association are split by local government jurisdictions. The area consists of land in 12 communities which are further divided into 3 rural districts and 3 government districts (local government status before a 1974 area redistribution). This political structure played no decisive or even impeding role, either during the founding or the performance of the endeavor.

The association today is made up of the city of Braunschweig, population 325,000, 476 farmers and 26 nearby communities. The decision-making body, called the association committee, consists of 20 farmers, each with one vote; two city representatives with 14 votes, which are 40 percent of the total of 36 votes; and two representatives of communities located on the pipeline, each with one vote.

Most of the communities bordering the irrigation area have decided to join the association. They pay 8.20 DM[2] a year for each inhabitant to help defray the costs of maintaining the sewer network and pumping stations. In addition, each community pays an equivalent charge (.20 DM a cubic meter[3]) that would otherwise be necessary if their wastewater were treated in individual sewage treatment plants. The wastewater flow from each community is metered to determine its equitable share of the system's operational and maintenance costs.

Chief responsibility for the system is given to the Chairman of the Braunschweig Administrative District because most of the wastewaters are produced there. The directorate or management section has five members—three farmers and two city representatives.

Direction of administration and operation is in the hands of an agronomist, who is assisted by a staff of 17. They have the task of providing for a controlled use of the wastewater. This involves operating the four pumping stations, shifting the sprinkler systems and maintaining and renovating association installations as well as advising agricultural members.

Although the association received State and Federal subsidies, loans and some planning assistance to help it get started, neither government regulates the association in any way. The loans are shared by all, and the city is responsible to the State and Federal Governments for repayment.

Construction costs of the system totalled nearly 28 million DM as of December 31, 1969, 3 years after the entire system was operating. About 36 percent of this cost was financed through bonds. The State (Lower Saxony Office of Lands) subsidized 30 percent and the Federal Government about 27 percent of the construction. Loans with debt service assistance paid some 36 percent, and the association made up the remaining 7 percent through loans and contributions.

Annual fees from association members cover operating costs. According to the operating budget plan for 1978, the city will be required to pay 2 million DM and farmers will owe 480 thousand DM. Limits to contributions are set by the advantages accruing to the members from wastewater reuse. Agriculture's present economic situation permits no considerable increase in farmers' contributions in the foreseeable future. In accordance with the association's charter, Braunschweig's share is limited by the costs which the city would otherwise have to bear if operating its own sewage treatment plant.

Getting Started

In the Braunschweig area, local soil and groundwater conditions are favorable prerequisites for spray irrigation. The soil-crop-rainfall-evapotranspiration cycle is of the right mix

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Mr. Schaerff was head of the Braunschweig District Department of Water Management from 1935 until he retired in 1970. Immediately after the war it was also his responsibility to find solutions for Braunschweig's wastewater problems. Nearly half of the city's homes were destroyed by bombs, which complicated his job.

[1] One hectare equals 2.471 acres.

[2] At the current rate of exchange, one Deutsch mark equals approximately 0.44 dollars.

[3] One cubic meter equals 1.31 cubic yards.

to make irrigation with wastewater profitable to the farmer and an economical disposal method for the city. Irrigation also contributes to groundwater recharge and supplements the usual water deficit of the April-September growing season.

A climatic water balance sheet, figured on an 80-year average, was used to estimate the size of the area required for disposal. Although the balance sheet shows an annual water surplus of 50 millimeters,[4] during the growing season the area actually loses more water through evaporation (122 millimeters) than is received in rainfall.

Accordingly, over the entire year of 300 sprinkling days, a total of 300 millimeters was determined to be the optimal supplement needed. This requires a total spray surface of 3,000 hectares to dispose of the wastewaters produced in Braunschweig and surrounding communities.

City officials selected a site and asked those farming within that area to join the association. Applying wastewater to farm land not only purifies and irrigates, it also adds humus beneficial to the soil—especially light, sandy soils such as those in the Braunschweig area. All the farmers contacted were willing to join, and they donated to the association the land necessary for access roads and installation sites.

Two problems remained. In order to sprinkle on an economical basis, the field plots must be either 300 or 600 meters[5] long and have boundaries as parallel as possible. In many cases, redistribution of land was necessary to align cultivated fields. Ownership did not change hands, but obstacles such as windbreak hedges and patches of woods were removed to create the large fields required. The redistribution resulted in a considerable improvement in the size and shape of fields even though it was not possible to achieve the ideal.

The second problem was to make both a timely removal of the wastewater produced and a timely application of the water according to the farmers' crop requirements. The two do not always coincide. For instance, the minimum wastewater volume flowing into the city pumping station occurs at 2 a.m. and the maximum volume at noon. In addition, there is a time lag in the flow from the city station to the four outlying wastewater stations that varies from 3 hours at station I to 6½ hours at station IV. Sprinkling takes place between 5 a.m. and 11 p.m. with an intermission at noon.

To compensate for these inequalities between production and irrigation demand, storage basins were constructed at the four stations. They have a total capacity of 15,500 cubic meters and are also used to clarify the waters. Holding time for settling the suspended solids varies from one-half to several hours, depending on flow rates from the generating sources.

Because no irrigation takes place on Sundays, holidays or during freezing periods—about 65 days a year—percolation basins were established at stations I and III. The first covers 7.7 hectares and the other 6.8 hectares. Whenever possible, these alternative areas are utilized to allow the soil under cultivation to dry out.

[4]One millimeter equals 0.0394 inches.
[5]One meter equals 39.37 inches.

In 1972 the association began phasing in irrigation machines to replace the old portable system that required many more employees.

Twenty-three years of wastewater irrigation and fertilization have transformed barren soils that produced minimal harvests into prosperous farm land.

BRAUNSCHWEIG
Sewage
Utilization Association
Lehrte
Wolfsburg
Oker
IV
B214
HILLERSE
III
II
I
DIDDERSE
ADENBÜTTEL
MEINE
RETHEN
NEUBRÜCK
VORDORF
GR. SCHWÜLPER
EICKHORST
GRASSEL
ABBESBÜTTEL
LAGESBÜTTEL
BEVENRODE
HARVESSE
SCHWÜLPER
HARXBÜTTEL
Hannover
WALLE
THUNE
BECHTSBÜTTEL
Berlin
Autobahn
ZWEIDORF
WENDEBURG
WENDEZELLE
WENDEN
BIENRODE
SOPHIENTHAL
Berlin
Canal
Hannover
BORTFELD
BRAUNSCHWEIG
Spray irrigation area
Sewage main pipeline with pumping stations I-IV
Sewage pipes
Associated communities
Sewage fields

The System

Braunschweig's wastewater is collected, at the city's expense, in a pumping station built in 1957. Here it is pumped through a concrete pipe gravity line, 6 kilometers long, to the transfer station. The line has a capacity of 2,700 cubic meters an hour.

The association then takes the flow from the transfer station through its own gravity line to the four pumping stations. This 15.4-kilometer conduit consists of concrete pipe at the beginning and asbestos cement pipe for the remainder. The pumping stations, which have the task of generating the required pressure to the sprinklers, are located approximately in the middle of the land area served. Each station has four spray pumps with capacities of 400 cubic meters an hour that pump from the settling basins. One or two sludge pumps are installed at each station.

The water is distributed throughout the area through an underground pressurized network of asbestos cement pipe that is 102.3 kilometers in total length. Asbestos cement pipe was used because it is considerably cheaper than cast iron or steel and has proven to be very satisfactory during many years of such use in this country.

Underground hydrants are used to transfer water from fixed to movable pipelines. They are placed at the most economical intervals—90 meters.

In 1972 the association began to phase out the original portable hand-moved irrigation system to reduce the number of its employees. The new technique uses flexible polyethylene plastic pipes in lengths of 270 to 330 meters that are pulled into place by a tow truck. They are retracted by a hydraulic motor driven by the water of the pressurized pipe network. The motor is mounted on a drum device that stores the hoses. A large-area spray head attached to the end of the plastic pipe operates during the retraction phase, sprinkling the wastewater over an area of 50 to 60 meters in diameter. After irrigation is completed, the tow truck pulls the machine to a neighboring strip of terrain for the next irrigation.

One hundred of these irrigation machines are being acquired to irrigate the 3,000 hectares. Their cost is financed by loans from the State, and the interest on the loan comes from savings in wages. Instead of the 20 spray attendants employed in the original system, only 6 to 8 are now required.

For a number of winters, excess wastewaters have been sprinkled on arable land with dormant crops. This method has proven to be viable and, together with the storage and alternative percolation basins, has made unnecessary the customary requirement that 25 to 30 percent of the total surface of an irrigation area must be pasture to be able to treat the wastewater at all times. The association irrigates only 137 hectares of pasture and 151 hectares of meadow.

During dry summer seasons, pure water pumped from underground can be made available by the city in addition to the wastewater it supplies. Wells have been installed at the pumping stations for this purpose.

The sludge produced daily at the settling basins is pumped to areas that are always divided into six basins. Of these, two basins are used for digesting and drying out, two basins serve as overflow, and two are used for preparation. The firm sludge resulting from the 6-month digestion process is simply carried off by association members and plowed under without any monetary compensation required.

The local groundwater table is completely favorable for spray irrigation. It lies generally more than 2 meters beneath the surface. Those spots having a higher groundwater table have underground drain tiles. These underground drain systems, together with the drainage system from the percolation

Recycled water percolating from the sprayed fields flows from tile underdrain into an open drainage ditch. These ditches, totaling 43.1 kilometers in length, carry the seepage and percolated water to the Oker or Erse Rivers.

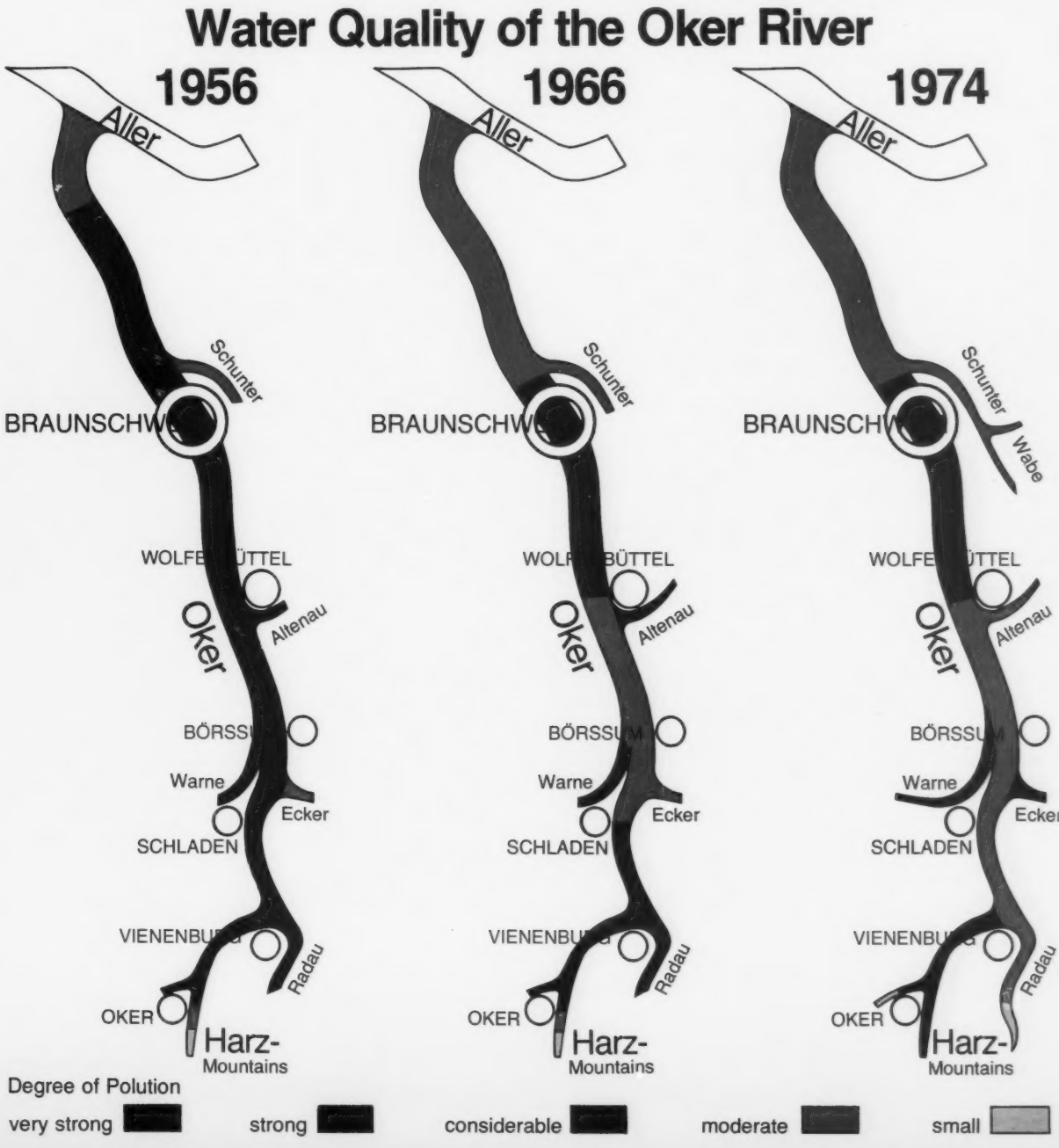
basins and the pressure of the underground water near the Oker River, made it necessary to construct open collection ditches to carry the seepage of percolated and natural groundwater to the two rivers. For those times when the natural outfall drains cannot function, bucket water lifts were erected at certain points at each river.

The Braunschweig land treatment system is completed by windbreak hedges established to protect access roads, paths and settlements from both spray and wind erosion. They also serve as a substitute for the wooded areas which were cleared and helped to improve the microclimate. Their maintenance and care is the association's responsibility.

Note the top segments. By 1966, the degree of pollution downstream of the Braunschweig irrigation area had decreased from considerable to moderate. By 1974, although the Oker upstream of Braunschweig had become more polluted, the degree of water pollution beyond the sprayed area remained moderate.

Agriculture

Every year each farmer presents his cultivation plan to the association. From these the association makes up an irrigation plan for the coming year that gives the correct quantities of water to be used at the appropriate time for each type of crop. The association's plan, which forms the basis for the irrigation operations, includes the number of hectares of each crop to be irrigated within each of the four pumping station



The cooperative's resourcefulness included construction of a dehydration plant to encourage continued cultivation of potatoes on a competitive basis. This allows better management of the wastewater.

The cooperative built four pumping stations to deliver the wastewater that irrigates the 3,000 hectares.

districts and the times at which the spray dosages will take place.

Winter and summer cereals, potatoes, sugar beets and asparagus are the association's principal crops. It is noteworthy that the cultivation of sugar beets, barley and wheat is made possible on the area's light, sandy soils because of the wastewater irrigation. The farmer not only achieves greater harvests with the help of spray irrigation; he can also cultivate additional fields and double crop some areas. Above all, harvests can now be reliably planned year after year.

The cultivation of hoed vegetables such as sugar beets and potatoes is extremely important for a controlled irrigation operation, for they are irrigated at different times from those of cereals. Just a few years ago, however, there was a tendency to grow more cereals and fewer potatoes because cereals sold for just as much and cost less to produce. Such a shift is undesirable because it results in peak periods of demand for irrigation.

The association countered this trend by building a dehydration plant in 1966 to dry potatoes and produce potato pulp. The drying plant is operated by a company founded for this purpose by the association and a neighboring cooperative. The facility is also used for drying cereals. Potato production declined 22 percent between 1966 and 1970 when production stabilized; however, national production fell 31 percent during this period. The drying process is used by members at cost.

Wastewater is valuable to farming for its trace elements as well as its fertilizers and the water itself. Half of Braunschweig's wastewater comes from households and half from industry. On the average it has a pH of 6.88, a nitrogen content of 51 milligrams per liter, a phosphorus content of 15 milligrams per liter, and a potash content of 23 milligrams per liter.

Health Concerns

Maintaining and furthering the health of humans, animals, plants and soils is the overriding principal when applying wastewater to land. Wastewater contains many types of morbific (causing or producing disease) agents. Most of the agents, especially parasite eggs, are removed from the wastewater with the solids in the settling tanks. Most of the remainder is destroyed in the decaying process to which the solids are subjected in the sludge holding areas. There are, however, still morbific agents present in large numbers in the clarified wastewater which is used for spray irrigation. (They are not destroyed in the traditional wastewater treatment process, either.) The State Medical Research Office at Braunschweig has determined through many years of investigation that these remaining morbific agents are destroyed in 1 to 2 weeks after coming into contact with soil bacteria.

Investigations of the infectiousness of wastewater have shown that salmonella are maintained in the soil for only a short time—on nongrass vegetation usually less than 2 weeks, at most 5 weeks, while on grass they are detected for 2 weeks at most. Enteroviruses are practically nonexistent. Persons having direct contact with the wastewater, spray attendants for instance, are given health examinations at specific intervals; and no ill health effects have ever been found. Furthermore, protective clothing and adequate laun-

dry facilities are provided for the employees.

Since a few farmers still take drinking water from the ground, it could be feared that irrigation and seepage in the alternative percolation areas could contaminate the groundwater used for drinking. Sixteen wells inside the farm areas have been observed continuously since irrigation began. It has been conclusively proven that the groundwater is not contaminated.

Except for asparagus which is sprayed only during the nonharvest months of June to December, vegetables and low growing fruit in the treated area are not sprinkled. All other field crops are processed before human or animal consumption so there is no danger that any disease bacteria remaining in the sprayed effluent and soil can be transferred to humans. Cattle cannot graze on irrigated pastures until 3 weeks after spraying.

Minimum distances are maintained between irrigated and inhabitated areas and public transportation routes. In addition, spraying in the vicinity of these areas is stopped during periods of high winds.

Odors are not a widespread problem at the Braunschweig installation because continuous testing has largely eliminated odor causing situations. The final solution to this seasonal and limited difficulty will probably consist of aerating the water with centrifugal aerators or airlift pipes before sprinkling. The association plans to install the necessary equipment in the near future.

Heavy metals found in wastewater can have a damaging effect on soil and vegetation. Since 1972, ongoing tests conducted in cooperation with a number of institutions have revealed that lead, zinc, copper, manganese, cobalt, cadmium, chromium and nickel exist in the wastewater and soil in quantities far below the standards established by the Federal Health Office.

The Results

Processing of wastewaters on agricultural land should be increasingly appreciated in the future, especially from the viewpoint of environmental protection. The Oker River's water downstream of the city and contributing communities is far cleaner than the water on the upriver side. Clearly, the Braunschweig Sewage Utilization Association, during its 23 years of existence, has shown that its soil treatment system is very effective in eliminating pollutants from water courses that flow through large and densely inhabitated areas.

The landscape in which the association area lies has regained much of its charm. Spring sandstorms which up to 20 years ago often appeared and blew away the shallow topsoil with the first sowing come no more. The farming that formerly produced only minimal harvests on barren soils owes its present success to the wastewater irrigation and fertilization. We now have clean waters, healthy soils and a landscape with waving fields of grain, grassy meadows and green hedges.

Although the prerequisites for agricultural treatment of wastewater are not present everywhere, agricultural processing should always be encouraged where favorable conditions prevail, as in Braunschweig. Not only is it effective and relatively inexpensive, it is environmentally valid. Nothing better can be done from the biological hydrological viewpoint to protect the waters, enrich the countryside and maintain the equilibrium of the natural water cycle. ■

Nutrient Value of Wastewater
Braunschweig Crop Yields

Year	Crop	CWB mm	No Sewage dt/ha	Sewage dt/ha	Increase dt/ha	Increase %
1959	Spring grain	−307	0	29.8	29.8	
	potato	−211	54.0	201.0	147.0	272
1960	winter rye	− 70	25.4	32.9	7.5	29.5
	potato	−108	253	302	49	19.4
1961	winter rye	+102	12.6	32.8	10.2	88.8
	sugar beet	+29	449	455	6	1.3
1962	spring grain	− 39	32.3	438	11.1	34.4
	sugar beet	− 5	142	315	173	122
1963	potato	− 71	235	324	89	37.9
1964	sugar beet	− 99	259	545	286	110
	winter rye	−142	16.0	27.0	11.0	68.8
1965	potato	+ 55	318	324	6	1.9
	spring barley	+ 77	24.4	41.3	16.9	69.3
1966	winter rye	− 10	22.5	30.2	7.7	34.2
1967	spring grain	+ 6	31.4	35.2	3.8	12.2
	potato	+ 15	320	312	8	− 2.5
1968	winter barley	− 96	20.8	29.3	8.5	40.8
	winter rye	− 96	24.6	36.5	11.9	48.3

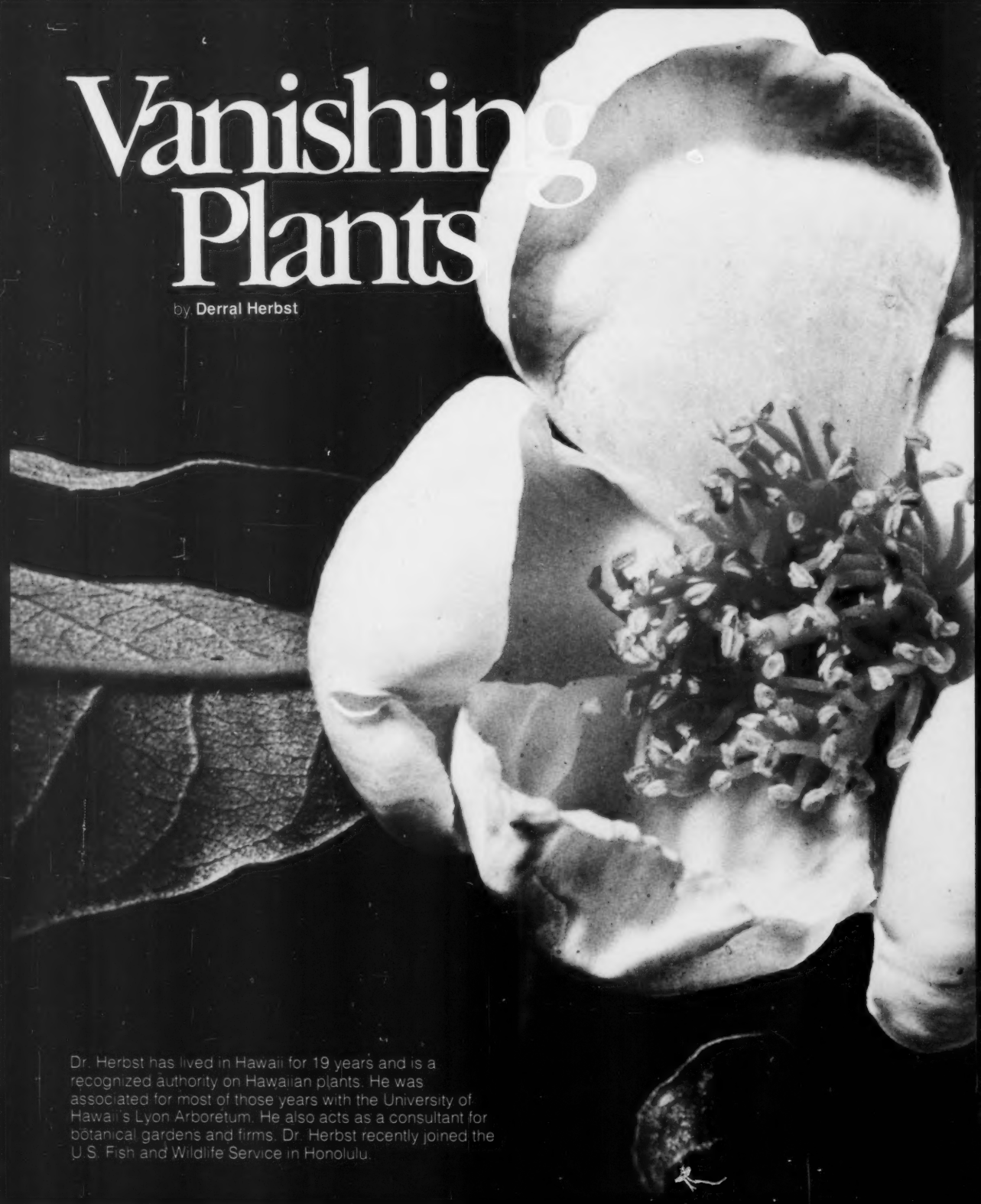
CWB = climatic water balance
Winter grain: April-June
Spring grain: May-July
Potato: June-July
Sugar beet: July-September

NOTE: $0.9842 \times 10^{3} \times$ kg = ton
2.471 × ha = acres
dt/ha = 100 kg. per hectare

Compiled by: Drs. Horst Ewert, Cord Tietjen and A. Bramm.

Vanishing Plants

by **Derral Herbst**



Dr. Herbst has lived in Hawaii for 19 years and is a recognized authority on Hawaiian plants. He was associated for most of those years with the University of Hawaii's Lyon Arboretum. He also acts as a consultant for botanical gardens and firms. Dr. Herbst recently joined the U.S. Fish and Wildlife Service in Honolulu.

Edward S. Ayensu

In the autumn of 1765, the famous American naturalists John and William Bartram discovered, as William later wrote: "... a flowering tree, of the first order for beauty and fragrance of blossoms." The brothers grew some of the plants in a botanical garden near Philadelphia, where the newly discovered tree was found to be a close relative of the *Camellia*. The Bartrams named it *Franklinia alatamaha* to honor their friend, Benjamin Franklin, and to designate the place where they discovered it by the Altamaha River near Fort Barrington, Georgia.

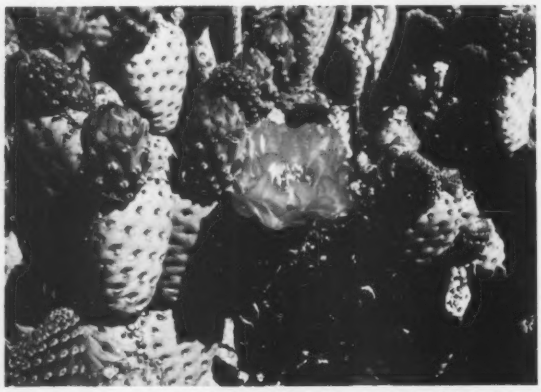
Although he explored the Southeast extensively, William Bartram later wrote that he "... never saw this beautiful tree growing wild but in one spot on the Altamaha about 30 miles from the sea coast (and) neither has any other person that I know of ever seen or heard of it." While there were abundant specimens of the tree, all were restricted to a small 2 or 3-acre plot near the river.

By 1784, the Bartram brothers had offered the plant for sale in Europe. It later was listed by their kinsmen, Humphry and Moses Marshall, in the *Catalog of American Plants*. Because of the beauty and fragrance of its flowers, the *Franklinia* was greedily collected by horticulturists. The Marshalls received orders for hundreds of plants from London nurserymen, including one from Grimwood, Hudson and Barrit requesting that they send "as many as you can" of *Franklinia*. It is known that Moses Marshall visited the Altamaha in 1790 ostensibly to fill commercial orders. It also is known that the plant was last seen in the wild in 1803. How ironic that the Bartrams, by cultivating *Franklinia* in their garden, not only saved the genus from extinction but also, by drawing attention to its ornamental value, may have caused its demise in the wild.

The *Franklinia* was the first plant species native to North America known to have become extinct in the wild, and it has been used as the unofficial symbol for endangered plants in the United States. Today 100 kinds of flowering plants on the U.S. mainland may be extinct; furthermore, no one knows how many kinds of lower plants have been destroyed.

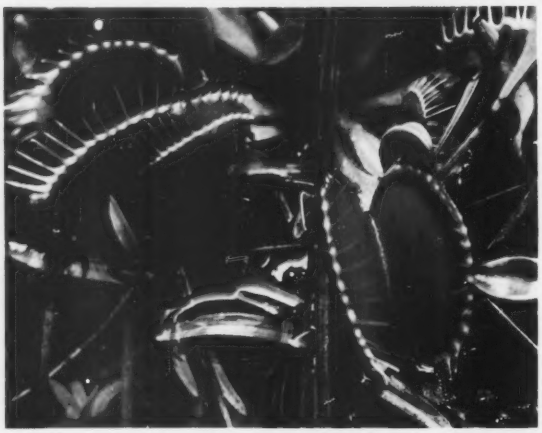
Commercial exploitation is a persistent problem. Nearly a third of our native cacti are candidates for the endangered species list, many because of over exploitation by hobbyists and commercial concerns. Yet cacti still are collected literally by the truckloads for commercial nurseries. The rarest species are in the greatest demand and thus command the highest prices; the high prices encourage dealers to seek and collect them; that species; the resulting decrease in wild, reproducing populations makes the species still rarer—and so the cycle continues. The collecting and growing of cacti and succulents is a popular pastime that has attracted a great number of people throughout the world. Their impact on the environment has been enormous. Although the cactus and succulent societies have encouraged their members to grow the rare species directly from seed, their efforts have not been entirely successful. Regulations published by the U.S. Fish and Wildlife Service in the June 24, 1977, *Federal Register* are designed to regulate such commerce through a permit system.

Carnivorous plants and orchids are also very popular horticultural items because of their beauty, novelty and



Robert F. Thorne

Because of commercial exploitation, nearly a third of our native cactus are candidates for the endangered species list. The beavertail cactus (Cactaceae opuntia basilaris *var.* brachyclada) *grows in California from San Bernardino to Los Angeles County.*



J. Dan Pittillo

Carnivorous plants such as vensus flytrap are threatened by commercial collectors. Native to the bogs and savannahs of North and South Carolina, Dionaea muscipula *is protected from picking in North Carolina by State law.*

G. Folkerts

Sarracenia alabamensis *ssp.* alabemensis *is endangered by commercial collecting and habitat destruction by herbicides and fast growing honeysuckle. Growing in bogs in the central part of the State, fewer than a dozen populations of the Alabama canebrake pitcher-plant are known to exist.*

mystique. There have been recent documented cases of commercial dealers collecting entire populations of rare carnivorous plants, and trees have been completely stripped of their epiphytic orchids in such remote areas as the jungles of New Guinea. The sad part is that many of these plants die before they reach the market, and even more are inadvertently killed by the amateur horticulturists who attempt to grow them. International trade in such plants is now regulated by permits issued under rules published by the Service in the February 22, 1977 *Federal Register*.

Commercial exploitation, however, does not eclipse the more basic problems caused by radical environmental changes. The destruction of habitats is probably the most serious of these. Plant habitats are continuously being altered or destroyed by man and his activities—over-grazing by domestic animals, drainage of swamps, marshes and bogs, strip mining, stream channelization, irrigation, flooding, destructive fires or the prevention of natural fires, construction, the release of pollutants into the environment, and the accidental or intentional introduction of predators, diseases and aggressive weeds.

A recent newspaper article described the effects of industrial pollutants on the flora and fauna of New York's mountain lakes. The pollutants—chlorides and nitric and sulphuric oxides—are spewed from factory smoke stacks and converted to acids in the atmosphere. Eventually they are washed from the sky by rain and snow. One, nitric acid, has increased in concentration fourfold in New York State over the past 10 years. The resulting acidic rains have killed fish, frogs, salamanders, microscopic animals and plants. Studies by Cornell University have concluded that more than half of the mountain lakes of New York State are now highly acidic and that the fish life in 90 percent of these has been destroyed.

The use of biocides has directly and indirectly affected plant populations. Fertilizers and herbicides pollute the air, water and soil, eliminating or changing populations of plant species. Insecticides used to control agricultural pests indiscriminately kill both harmful and beneficial insects. The plant pollinators and the predators of insects injurious to plants are destroyed along with those few insects that attack commercial crops.

The balance of nature is delicate; the web of life poorly understood. An act that may seem beneficial or of little consequence can have unknown long-range ramifications on the environment. The environmental consequences on each of the activities of man mentioned above could be the subject of a separate article, but the brief examples I have used give some insight into the causes of rarity.

In 1975, the Smithsonian Institution, acting upon an order of the Congress, published a list of candidate endangered and threatened plant species of the United States. The list includes about 10 percent of all higher plants in the United States. Some 1,700 taxa or classifications of these were later included on a revised list of proposed endangered species published by the Service in the June 16, 1976 *Federal Register*. About 50 percent

of the plants on the latter list are native to the Hawaiian Islands. The rest are scattered over 45 States.

Why is Hawaii so exceptional? The answer can be summarized by a single word: isolation. Hawaii is at least 2,000 miles from the nearest high islands or continental land masses. It may seem almost impossible that a viable seed would ever find its way to such a small, isolated region of the vast Pacific, but approximately 265 species of flowering plants became established here out of the unknown number that arrived and failed to survive. These 265 founders can account for all the 2,750 or so species, subspecies and varieties of flowering plants native to Hawaii.

When a plant species arrives on an island, the environment is usually without natural predators and competitors. Until balance can be restored, a successful arrival usually can be expected to produce enormous numbers of offspring which move into all available space. Often some are able to survive in environments totally alien to their ancestors. When their numbers are brought into check, small isolated colonies sometimes are found. With their limited gene pool and through the accumulation of the expected changes in their genetic makeup, they soon become different enough to be recognized as new varieties, species or subspecies. Bizarre forms at times are maintained simply because there is nothing more successful or efficient competing with them.

Isolation has made Hawaii a workshop for evolution; it is recognized throughout the scientific world for this. Hawaiian flora and fauna, and the knowledge to be gained through their study, are an important part of mankind's legacy. A few shortsighted individuals interested only in the immediate dollar should not be allowed to destroy that which belongs to the world.

Isolation has prevented early natural introduction of grazing, browsing, trampling animals and their colonization here. Since 97 percent of Hawaii's native flowering plants evolved in the islands, they did not develop defenses against herbivores for they did not need them. Few have prickles, poisons and deep root systems and few can withstand either the attacks of the animals that man introduced or, for that matter, man himself.

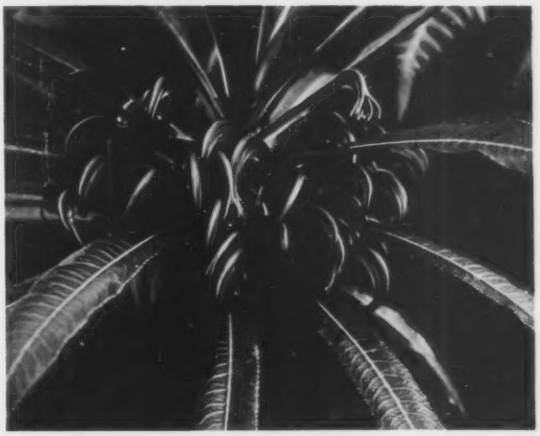
Man first settled on Hawaii about 1,500 years ago, when Polynesian explorers arrived on the pristine shores of these islands. They burned and cleared land for crops and villages; pigs and rats were introduced; and some of the plants they brought with them began to compete with the native ones for available space. Undoubtedly some plant species became extinct then, but there is no way to know how many.

The mass destruction of Hawaiian plants began with the introduction of goats and English pigs by Captain James Cook in 1778. Fifteen years later, George Vancouver, an English sea captain, brought sheep and cattle.

Goats have been introduced into many islands throughout the world to provide a source of protein for passing ships. They probably have caused more destruction than any other creature, save man.

Kapu, a taboo placed on cattle by the king of the Islands, allowed the buildup of great herds until their destruction of plants was so enormous that man was forced

Ken Nogata



The Rollandia angustifolia, *a member of the bellflower family, is found only in the forests of Oahu. Its blossom is shaped to fit the curved beak of the honey creeper.*

Derral Herbst

The endangered Sesbania tomentosa, *a member of the pea family, grows on the coastal sand dunes of Hawaii. It is one of nearly 3,000 species, subspecies or varieties that evolved from 265 founder plants on the isolated Islands.*

Derral Herbst

The beautiful Hibiscus kahilii *is a candidate for the endangered species list. It is found only in the Wahiawa Swamp on the Island of Kauai.*

John Wurdach

Only two populations of the Tennessee cone flower (Echinacea tennesseensis), *which grows in cedar glades near Nashville, are known to exist. One is on private land; the other is in a State forest. The destruction of a third population was discovered in May 1977.*

Marshall C. Johnston

The rare and lovely Prunus havardii *grows only on the rocky slopes and canyons of the Trans-Pecos region in western Texas.*

to contain or destroy them. Weedy species also followed the animals, taking advantage of the disturbance they made.

The land management policies of large estates, foresters, speculators and developers have made a shamble of the islands with the result that more than two-thirds of the extinct plants in the United States are of Hawaiian origin. Hawaii's natural resources, which could be a source of pride to the State, have become its shame; more so for those with the power and ability to have prevented it.

What has been done cannot be undone: there is no way that a species can be recreated or that a balanced association of plants and animals in an ecosystem can be restored to its original state, once disturbed. What man can do is attempt to save what is left. It is too late for many species, but there is still enough time to conserve others if we act now.

What can be done?

Plants can be brought into cultivation. This is best done in arboreta and botanical gardens. Plants for private gardens should be obtained from those already in cultivation for—remember the *Franklinia*—mass wild collections of plants or propagules* for the horticultural trade can result in the destruction of that species in the wild.

Cultivation, however, is probably the least satisfactory way to maintain a species. The small number of plants which can be placed under cultivation will result in a very limited sampling of the available gene pool. Perhaps some of the most valuable genetic factors will be lost. The plants are, of necessity, "grown out of context." Natural populations, associations and environments are lacking. The different environmental and selective forces at play will eventually cause a change in the species.

Another factor about cultivation to be considered in Hawaii is its general lack of genetic barriers between species or, for that matter, certain genera. The isolating barriers contributing to speciation in the Hawaiian flora are primarily geographical. Removing the geographical barriers, as we do when we develop a collection of plants in a garden, may result in the formation of an artificially induced hybrid swarm rather than preservation of a rare plant.

Thus, care should be taken to preserve the integrity of the taxa involved. A hybrid may be more vigorous and attractive than either parent, but it should not be maintained at the expense of the natural parental lines.

It isn't that rare and endangered species should not be brought into cultivation. They should be, but only as a back-up safeguard in event of the loss of those in the wild.

The only satisfactory way to preserve a plant is to conserve its environment. This cannot be done by building a fence around a single plant or around a 5-acre plot of trees. It has been tried without particular success. It tends to merely slow down rather than prevent eventual extinction caused by man.

Samples of different ecosystems should be set aside in large tracts of land with adequate buffer zones. Roads and

**Any part of a plant that can reproduce, a cutting or seed for example.*

trails should not be developed into these areas; they would merely facilitate access by aggressive weeds and casual tourists. Hunting should be encouraged to keep down the population of exotic (foreign) animals that are destructive to existing native species.

Several States have passed laws which encourage private landowners to preserve both natural and key wildlife areas. Under these conservation easements, the property owner voluntarily gives up his right and anyone else's—heir or future buyer—to develop or to change the traditional use of the land. In return, the economic value of the land may be reduced to, say, a tenth of its market value. This permanent decrease in value would become a contribution to a charitable organization, the Nature Conservancy for example, giving the landowner an enormous Federal income tax deduction, lowering property taxes and reducing inheritance taxes. Perhaps a law of this sort would induce some large landowners in Hawaii to forego development of certain natural areas. They would not be compelled to develop an area in order to meet the rising cost of taxes which, in Hawaii, are based upon best use rather than actual use of the land.

Hawaii has a system through which natural areas can be set aside for conservation. However, the poltics involved have reduced its effectiveness to a painfully slow pace.

The U.S. Congress passed acts for the conservation of endangered species in 1966 and 1969, but they were for the conservation of animals only. The Endangered Species Act of 1973, a revision of the earlier acts, rectified this omission and specified that protection should be provided for endangered and threatened species of fish, wildlife and plants. The act defines as endangered "any species which is in danger of extincition throughout all or a significant portion of its range," while a threatened species is one "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." A species can be considered threatened or endangered if any natural or manmade factor is jeopardizing its survival. This may consist of depletion of population due to disease, predation or overuse for commercial, sporting, scientific or educational purposes. The jeopardy may also be the destruction or modification of its habitat or range.

The purposes of the Endangered Species Act are:

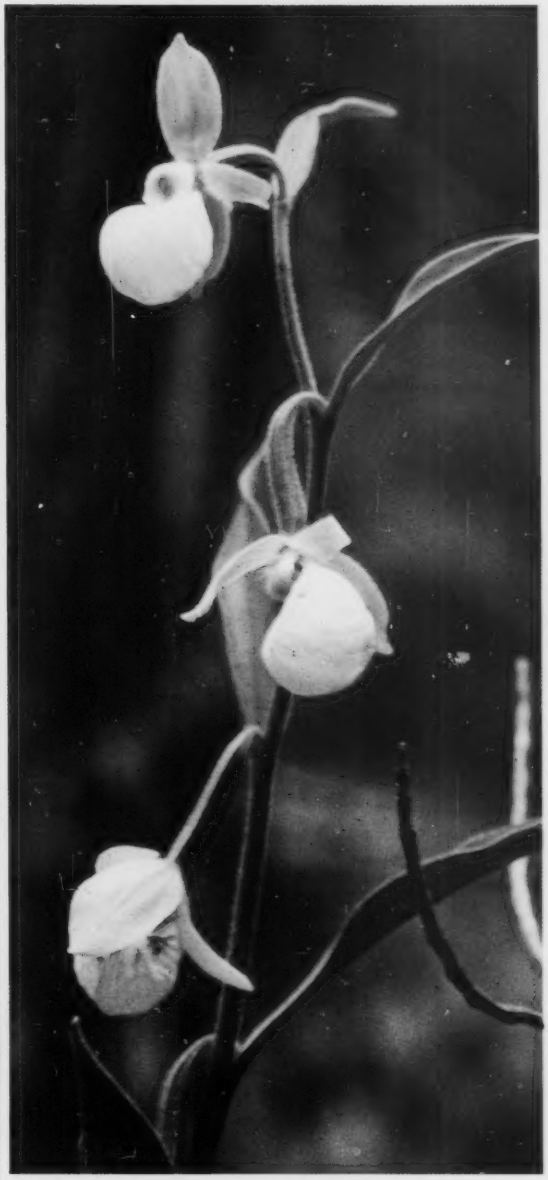
- ☐ to conserve the ecosystems upon which threatened and endangered species depend.
- ☐ to provide a program for the conservation of threatened and endangered species, and
- ☐ to insure that the United States upholds its part of certain international treaties and conventions to which it is a party.

In the 1973 Act, the Congress directed the Smithsonian Institution to prepare and submit a review of threatened and endangered plant species within a year. The task was officially headed by Dr. Edward Ayensu, chairman of the Smithsonian's botany department. A list was compiled and published in 1975 as House Document No. 94-51. It was later accepted and published by the Service in the July 1, 1975 *Federal Register*.

To summarize the Smithsonian list:

	Plant Taxa	
	Continental United States (including Alaska)	Hawaii
Endangered	761	639
Threatened	1,238	194
Extinct	100	255
Total	2,099	1,088

G. Wallace



Because of its limited range—it grows in only eight California and Oregon counties—the orchid Cypripedium californicum *is a candidate for the threatened species list.*

Thought to be extinct until some 200 specimens were discovered last year along a bank of the St. John River in Maine, the furbish lousewort may help keep the Corps of Engineers Dickey-Lincoln Dam hydroelectric project from being built.

A later list was published in the June 16, 1976 *Federal Register*. It proposed some 1,700 plants as endangered; primarily those recommended earlier by the Smithsonian. Hawaiian plants accounted for 892 of these

And there it rests. Not a single plant has come under the protection of the act. It is estimated that it will take a minimum of 36 professional man days to legally list a single plant or animal species. The staff at the U.S. Fish and Wildlife Service that which is responsible for such things is woefully small for the task it has undertaken. It has been estimated, not too much tongue-in-cheek, that the Department of Interior, working at its present rate, will require about 6,000 years to list all the plant and animal species in the world that presently need protection by the Endangered Species Act.

Section 7 of the Endangered Species Act states that "all Federal departments and agencies shall . . . insure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of . . . endangered species and threatened species or result in the destruction or modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with the affected States, to be critical." The potential effect of this section upon the activities of the Army Corps of Engineers and other government agencies, both Federal and State, is enormous. And the effect is already being felt. Witness the Corps of Engineers Dickey-Lincoln Dam project in Maine where a relative of the snapdragon, once presumed extinct, is one of the factors which may cause the $600 million hydroelectric project to be abandoned.

Of what value are endangered species? Are they worth the money and effort required to protect them and their habitat?

Extinction is a natural process, but it has been speeded up by man and his activities. Today 100 kinds of flowering plants in the continental United States are thought to be extinct. Beginning with the *Franklinia,* that averages out to approximately one every 1¾ years. In Hawaii, the average is probably closer to one every 9 months. While the comparison may not be entirely valid, the natural extinction rate of the dinosaurs is believed to have been something like one every 1,000 years.

As the title of a recent New York Botanical Garden book states, "Extinction Is Forever." There is no way that a species and its natural diversity once lost, can be restored.

The key word is "diversity." The diversity of a natural gene pool can make many contributions to our well-being. Selection and plant breeding, using the diverse genetic reservoirs of the wild relatives of our cultivated plants, may produce a disease-restistant tomato for the truck farmer; a tall, straight, fast-growing tree for the timber industry; or a new drug for the pharmacologist. With the extinction of a species the source material for a new medicine, potential food, beverage, pesticide, ornamental or industrial product may be lost. And don't forget aesthetics. Much of the beauty of our world is due to its diversity. As Emerson so aptly phrased it: ". . . if eyes were made for seeing, beauty is its own excuse for being."

A Regional Partnership That Works

by **Lucy Justus**

The Metropolitan Atlanta Water Resources Study began in 1973 in an atmosphere of uncertainty about what could be accomplished.

Part of the goal was to produce an implementable plan assuring the area that all its water resource needs would be met through the year 2000. That plan was to include an adequate supply of water for domestic and industrial use, for recreation, for fish and wildlife, and a guideline for wastewater management. It was also to contain solutions to flood control problems.

As originator of what more informally came to be called the Atlanta Urban Study, the U.S. Army Corps of Engineers began by establishing an executive group initially composed of representatives from the four major water resources oriented agencies at the Federal, State and local levels. They were Jack Ravan, regional administrator for the U.S. Environmental Protection Agency; Leonard Ledbetter, director of the Environmental Protection Division (EPD) within the Georgia Department of Natural Resources; Harry West, executive director of the Atlanta Regional Commission (ARC), and Colonel Edwin C. Keiser, then Savannah District Engineer for the Corps.

Closer coordination would be needed to carry out the study than had sometimes been the case in the past. The Corps' planning process was an unknown factor to the other agencies. One of these, ARC, was to be responsible for coordinating the study between the Corps and the public officials from Atlanta and the surrounding cities and counties. Complicating this coordination, was the additional need to overcome the tendency, in the metropolitan area, to interpret the word "regional" to mean dictation by the city of Atlanta, with the city receiving most of the benefits. Consequently, the possibility of a regional water plan raised doubts in the minds of most local officials. It was the Regional Commission that

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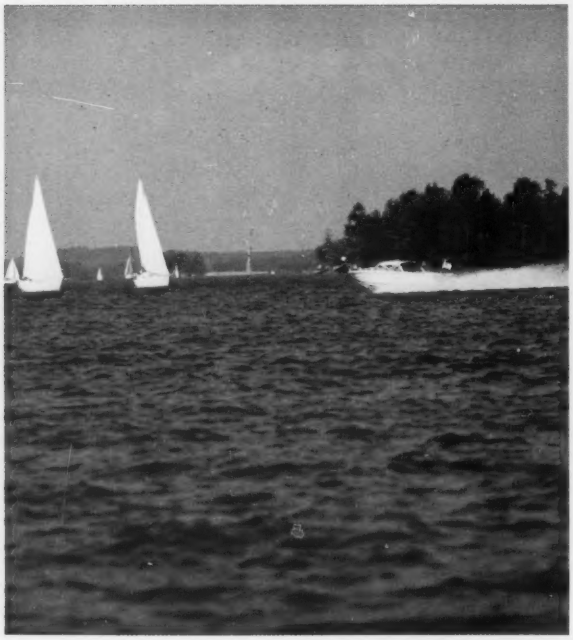
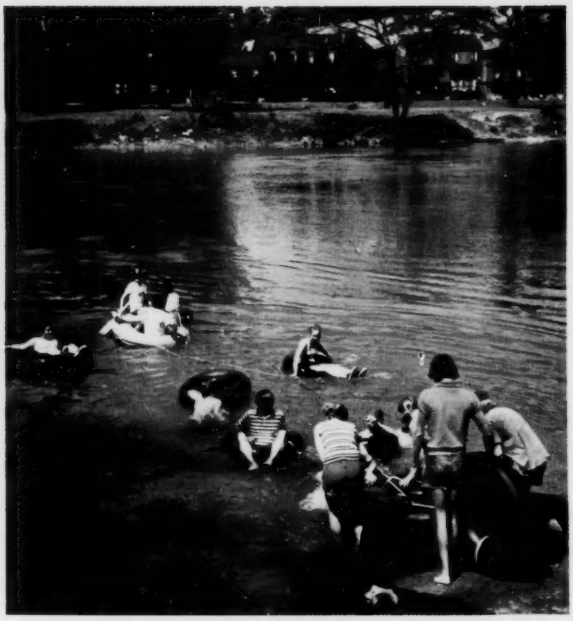
Ms. Justus has written for the *Atlanta Journal* and *Constitution Magazine* for several years.

Editor's Note:
For several years the Corps of Engineers has joined with local communities in a number of Urban Studies to determine future water resource needs for designated new study areas. Achieving success for such studies requires forging solid institutional links that bind multiple working elements into a cohesive task force. The record of such an endeavor begins below.





Primary sources of water for metropolitan region are Chattahoochee River and Lake Sidney Lanier.

coordinated the study with public officials of the cities and counties.

To the average man-on-the-street, water came from God, who increased the supply every time it rained. Not everyone realized that the world's water supply was fixed at the beginning of time and the supply is finite. Fewer still realized that if nothing was done in the near future, the Atlanta area could face a severe water crisis.

Metropolitan Atlanta rests on the crystalline rocks of Georgia's Piedmont Plateau and has virtually no groundwater. Peachtree Street, running through the heart of downtown Atlanta, lies along the continental ridge line dividing the Atlantic Ocean and Gulf of Mexico drainage basins. Therefore, most of its major urban streams are small and polluted because of the small drainage area and lack of sufficient water for dilution. The primary sources of the region's water are the Chattahoochee River and Lake Sidney Lanier, formed by Buford Dam, which is about 48 miles north of where Atlanta's Peachtree Creek enters the Chattahoochee.

The metro area already was growing rapidly at the time the study was proposed. New people, businesses and industries were moving in and projections indicated that, if the present trend were to continue, the population would more than double by the year 2000.

The question then was: could this unlikely group work together to produce an acceptable plan to meet the region's needs for the future?

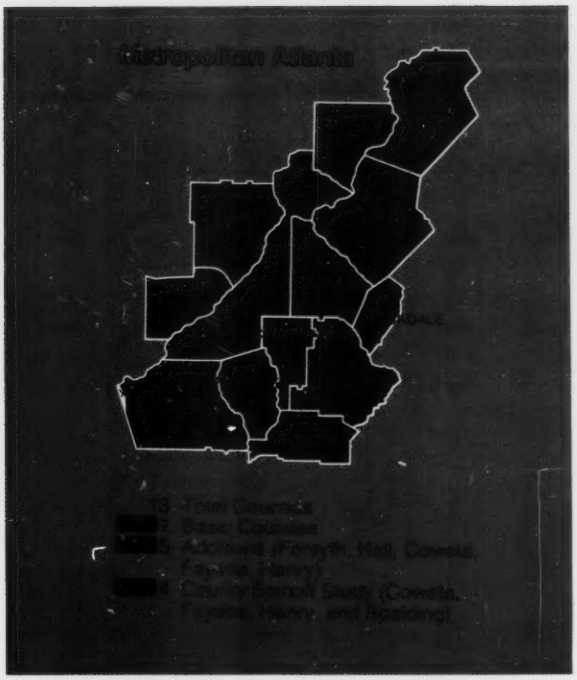
That in itself was an enormous task, but it soon became apparent that still more was required. There were immediate needs to be met. Cities and counties were requesting permits for new water and wastewater facilities along the Chattahoochee. Some were actually under construction when the study began. In the past, such permits had been issued and the facilities designed on the basis of the minimum flow of the river. Georgia's EPD established a policy requiring that instantaneous minimum flows be at least 750 cubic feet per second at the confluence of Peachtree Creek and the Chattahoochee to facilitate the assimilation of wastewater.

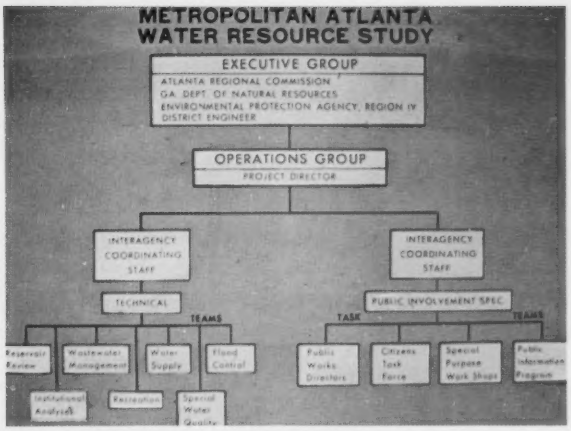
The State's intent was to meet downstream water quality objectives. However, there was no assurance the final study plan for Atlanta's water needs would maintain that minimum flow. To avoid such an eventuality, EPD's Ledbetter asked the executive group to direct the study group staff to develop an interim water supply plan covering the next 10 years. The purpose was to assure the region its minimum flow while observing the plan's effectiveness in meeting both near future and long-term water demands.

The Study Begat Studies

Buford Dam, built by the Corps of Engineers in 1955, was obviously to play a major role in any regional water plan for two reasons. Releases from the dam, used to generate power and aid downstream navigation far below Atlanta, control the flow of the river. In addition, nearby counties draw their water directly from Lake Sidney Lanier. When the dam was built, its congressionally authorized purposes were limited to flood control, hydroelectric power generation and downstream navigation. It has since become the most popular Corps lake in the Nation, attracting more recreation visitors each year than the Great Smokies, Yellowstone and the Grand Canyon National Parks combined.

Buford Dam and Lake Lanier could not continue to support the authorized functions and release additional millions of gallons of water to meet the needs of the Atlanta region while also maintaining the intensive recreational use that had developed around the lake. A complete restudy of the lake and its uses became necessary, requiring the cooperation of the Mobile District of the Corps, which operates the dam, and the





Organization framework illustrates how cooperation was encouraged among region's participating agencies and citizens.

The study, begun in 1973, concentrated on Atlanta and seven surrounding counties. It was later expanded to include five more counties (shaded). It was modified a second time in 1976 when Governor Busbee requested the group to prepare a detailed plan for four southern counties, indicated here by cross hatching.

Savannah District, which was involved in the Atlanta Urban Study and would, therefore, conduct the restudy of Lake Lanier. Both districts are within the South Atlantic Division of the Corps.

The basic study, intended to examine the problems and needs of seven Atlanta region counties, was modified twice. It was expanded in scope to consider the interrelated problems of five other counties adjoining the study area to the north and south. Obviously, use of the Chattahoochee north of the study area would affect the quality and quantity of the water within the basic seven counties. Then, in the fall of 1976, as three contiguous counties and one additional county to the south became aware that Atlanta's use of water and disposal of its wastewater could affect their own water supply problems, officials of the counties involved and Governor George Busbee requested the study group to begin work on an assessment of water supply needs for that four-county area. This brought to 13 the number of counties involved.

Currently, the interim water supply plan and the wastewater management segment of the Atlanta Urban Study have been completed and are being implemented by State and local officials. These will form the foundation for developing future plans for managing the upper Chattahoochee and Lake Lanier system which are scheduled for completion in early 1978 while studies for the four southern counties should be finished in the latter part of 1977.

Despite its beginning in a lackluster, yet potentially volatile atmosphere, the Metropolitan Atlanta Water Resources Study has clearly been successful and some of the methods used could be a model for others around the country.

A major institutional obstacle in implementing a regional water supply plan was overcome when the 1977 session of the Georgia General Assembly passed a bill giving the State EPD control over Georgia's surface water supplies. Under the new statute, all counties, cities and industries using more than 100,000 gallons of water per day are required to obtain a withdrawal and use permit from EPD. Significant increases in consumption require a new permit, which can be denied if EPD determines that the increase would harm others using the same water supply.

EPD's director contends the costs and efforts devoted to the Atlanta Urban Study have already been returned through adoption and initial implementation of the interim water supply and wastewater management plans. "If the study did not do anything else, it has already been worth the time and money spent on it," Ledbetter observed.

Why and how did the study succeed? A key factor in the spirit of cooperation that grew out of the initial meetings has to be the foresight and sensitivity of Colonel Keiser, former District Engineer, and Lieutenant Colonel Roger Foley, former Deputy District Engineer, who were with the Savannah District of the Corps through the crucial early stages of the study. Their attitude made the other lead agencies quickly realize that the Corps was truly intent on cooperating with them.

In Georgia, which has more than 50 environmentally oriented organizations, the Corps of Engineers has been labeled a dam-building outfit that bulldozes its way through fragile ecosystems and the sentiments of landowners whose property has been passed down through families for generations. While governor of Georgia, President Jimmy Carter personally intervened in at least two controversial Corps projects in the State.

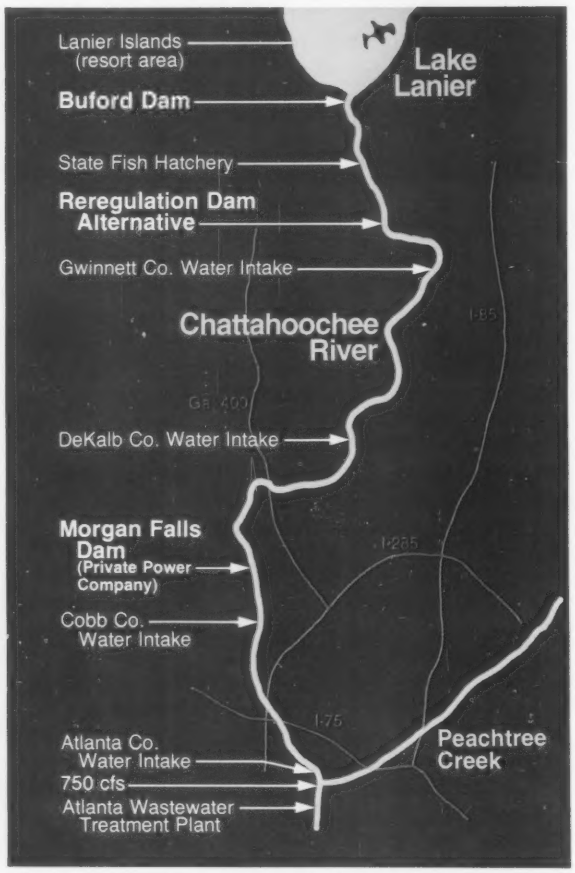
With the Corps supplying the money, the organizational framework and much of the personnel for the study, the question lurked in many minds as to whether the other agencies would share equally with the Corps in the decision-making process. In other words, would the Corps dominate the study? Were the Engineers really concerned about urban

water problems, or was the study a thinly veiled excuse to find justifications for building additional dams in a State where dam building was becoming increasingly unpopular?

Such suspicions were not easily overcome. The first step was a memorandum of agreement signed by all the agencies outlining their specific responsibilities during the conduct of the study and guaranteeing that each would have an equal share in those responsibilities. The participating Corps officials proved to be men who were willing to listen and to "bend"—even to the point of examining possibilities outside the current policy of the Corps. One example was their willingness to consider whether the authorized purposes of Buford Dam should be modified by adding others.

The Public Participated

Public works officials from the counties involved were brought into the study in its beginning stages and have remained a vital part of it. Participation by a progressively informed public was also an important factor in the study's success. The Corps hired environmental engineer Larry E. Lyons to serve as its public involvement specialist and to direct the water supply part of the study. He maintained an Atlanta field office for the Savannah District for the duration of the study for these purposes.



Final plan for water supply may include a small downstream dam to reregulate fluctuating hydroelectric power releases from Buford Dam.

The program involved publishing brochures, posters and a monthly newsletter; conducting public meetings, presentations and workshops; and forming a Citizens Task Force. The latter was composed of a broad cross section of private citizens and public officials with diverse backgrounds and interests. It included representatives of the Georgia Conservancy, the Metropolitan Atlanta Homebuilders Association, the four Georgia Area Planning and Development Commissions covering those counties in the study, Friends of the River, League of Women Voters, Save America's Vital Environment, Society of American Foresters, Georgia Power Company, Georgia Society of Professional Engineers, Georgia State University and a number of other organizations. There were also two State Assembly representatives and a State senator.

The Citizens Task Force has met more than 40 times during the last few years to study issues and alternatives, provide input to the study, and inform families, friends and civil groups about the various aspects of the study.

Study manager William Porter of the Savannah District described the process by saying that once the organizational framework—the executive committee, a technical staff including members from all four agencies and the public involvement program—was established, the rest was "just a lot of hard work."

The hard work began as agencies formulated numerous possible wastewater management alternatives. Some were totally unfeasible, some were excellent and some had merit in one area but not in others. Nevertheless, all were considered. In many instances, the better parts of some were combined with the better parts of others to produce new possibilities. Through a long process of elimination, these were narrowed down to a few that were presented to the public for comment in July 1975. Further study followed, ending in adoption of a final wastewater plan by the Regional Commission and seven counties in the summer of 1976 by ARC. Then EPD certified it as part of the State's water quality management plan and EPA approved it at the Federal level. A similar procedure also has been used by all other phases of the study.

Two potential water supply alternatives in the Lake Lanier Restudy drew heated adverse response from the public. One would have lowered the level of Lake Lanier by some 35 feet below normal summer pool level during periods of extreme drought. That had been a possibility under current power operating procedures since the lake was built, but apparently many people had forgotten or were never aware of it. Since 1957, many expensive year-round and second homes have been built on the lake shore; and recreational use of the lake brings hundreds of thousands of dollars a year into the economy of Hall and Forsyth Counties within whose jurisdictions the lake was created. Lowering the lake level would leave an unsightly strip of "government" mud edging the private lawns of many expensive homes and would possibly reduce the income from tourism.

At a 1974 public meeting in Gainesville, the seat of Hall County, more than 2,000 people turned out to strongly protest any alteration of the level and to urge that Lanier be reclassified as a "recreational" lake.

As an alternative to lowering the level, the study group considered the possibility of constructing two new dams above Buford, one on the Chestatee River and one on the

Georgia's Governor George Busbee watches demonstration of fluctuating Chattahoochee River flows, caused by peak power releases, during inspection of Buford Dam site conducted by Corps personnel. Accompanying him are the director of Georgia's Environmental Protection Division, Leonard Ledbetter, and Brig. Gen. Kenneth McIntyre, South Atlantic Division Engineer.

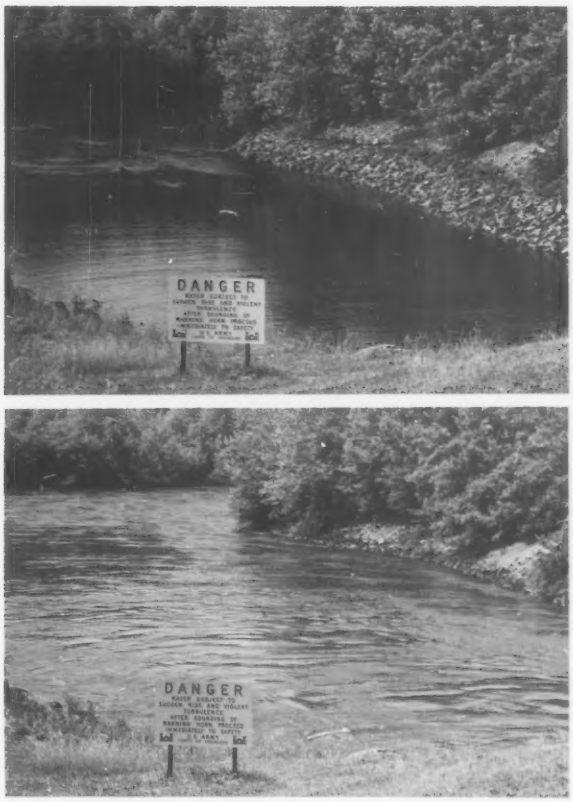
upper Chattahoochee River in the north Georgia mountains. These dams would be used to maintain the level of Lake Lanier during periods of drought when additional water would be released to supply the Atlanta region's needs. In its simplest form, this alternative would have meant transferring the unsightly mud from Hall and Forsyth Counties farther north. Residents upstream failed to see why they should accept this alternative and objected as vigorously as "Lanierland" (area people living or recreating at the lake) had to lowering the level at Lanier. Other strong contenders were reducing or eliminating power at Buford Dam or raising the pool level at Lanier.

The final water supply plan may not include any drastic lowering of Lake Sidney Lanier or the building of additional dams north of the lake, but power curtailment is still a possibility. It may include placing a small reregulation dam on the Chattahoochee below Buford Dam to help smooth out the downstream flow. The purpose of the reregulation dam would be to capture the fluctuating power releases of water required to meet the daytime demands for peak hydroelectric power. This reregulation dam proposal became one of the Lake Lanier Restudy alternatives presented at public hearings held in May 1977 at both Gainesville and Atlanta.

Evaluating Success

Colonel Foley, now assigned to the U.S. Army Engineer School at Ft. Belvoir, Virginia, feels the study can be evaluated in many ways. "I believe one of the strengths of the Atlanta study was the participants' unwavering orientation on implementable outcomes."

Commenting on what he believes to be the essence of the study's success, he adds: "It must also be understood that this was *not* just a superficial, letterhead only involvement, but a genuine partnership. The authority-sharing, planning



Chattahoochee's low flow drops to 450 cfs nights and weekends from a peak power generation of about 8500 cfs during weekdays. Periods of high and low flow restrict water for other uses downstream.

partnership may now appear to be a self-evident need, but I can recall how delicate a position it was initially. Hesitancy and caution were exhibited at all levels in the ad hoc study organization. I continue to believe that this rather simple idea and the deliberate, active maintenance of a sharing environment is a key element in the success of the study."

In support of Colonel Foley's evaluation, the fact should be brought out that the other lead agencies were considered joint partners in the study, helping to write the scope of work on several contracts and to select the contractors. They also performed specific tasks within the planning process for various study components. Frequent meetings and telephone contacts among the separate staffs characterized the daily communications during the progresss of the study.

Robert Humphries, an environmental group's representative serving as chairman of the Citizens Task Force, considers the study extremely successful but is of the opinion it has not been as well rounded as it was intended to be. Water-related recreation and fish and wildlife needs were given less consideration than he would have liked. Study officials, however, interpret accomplishment of the *detailed* planning of the recreation and the fish and wildlife segments as a local responsibility and have made their planning data available to concerned local officials for further action.

Extremely important, Humphries adds, is the fact that the study . . . "forced a recognition of the problems. The study

One Atlanta resident chose his own flood proofing alternative. He elevated his home above projected 100-year flood level for Peachtree-Nancy Creek flood plain.

has been worth more than it cost just in that respect. It has also created a well-educated cadre of agencies and citizens who have a better insight into the politics and technicalities of our resources."

By the time he had conducted his 30th task force meeting, Humphries' enthusiasm compelled him to state for the record that "this has been the outstanding public participation process in water resources in the entire United States."

Colonel Frank Walter, present Savannah District Engineer, points out that a spinoff of the urban study has been an evaluation of the flood control problems in the Peachtree-Nancy Creek area, an affluent section covering a sizable portion of north Atlanta. Through the years the area has experienced severe flooding, especially in 1975 and 1976. The non-structural proposal will probably involve evacuating some homes from the flood plains and flood proofing others.

The flood control study will also recommend actions the State and local governments can take to relieve damage along the flood plains, such as the enactment of stronger ordinances for regulating watershed development and establishing requirements for controlling rainwater runoffs in the construction of shopping centers, industrial buildings and homes. From its beginning the Atlanta urban study has been a learning process for all its participants, a process marked by a growing sense of urgency. While the average citizen did not realize the situation was approaching a crisis point, the Federal, State, county and city officials who had to cope with the problems became well aware of it. There was a definite possibility, if nothing were done, that the region would soon reach a stage where further growth could not be considered because water resources would be too limited to meet additional demands.

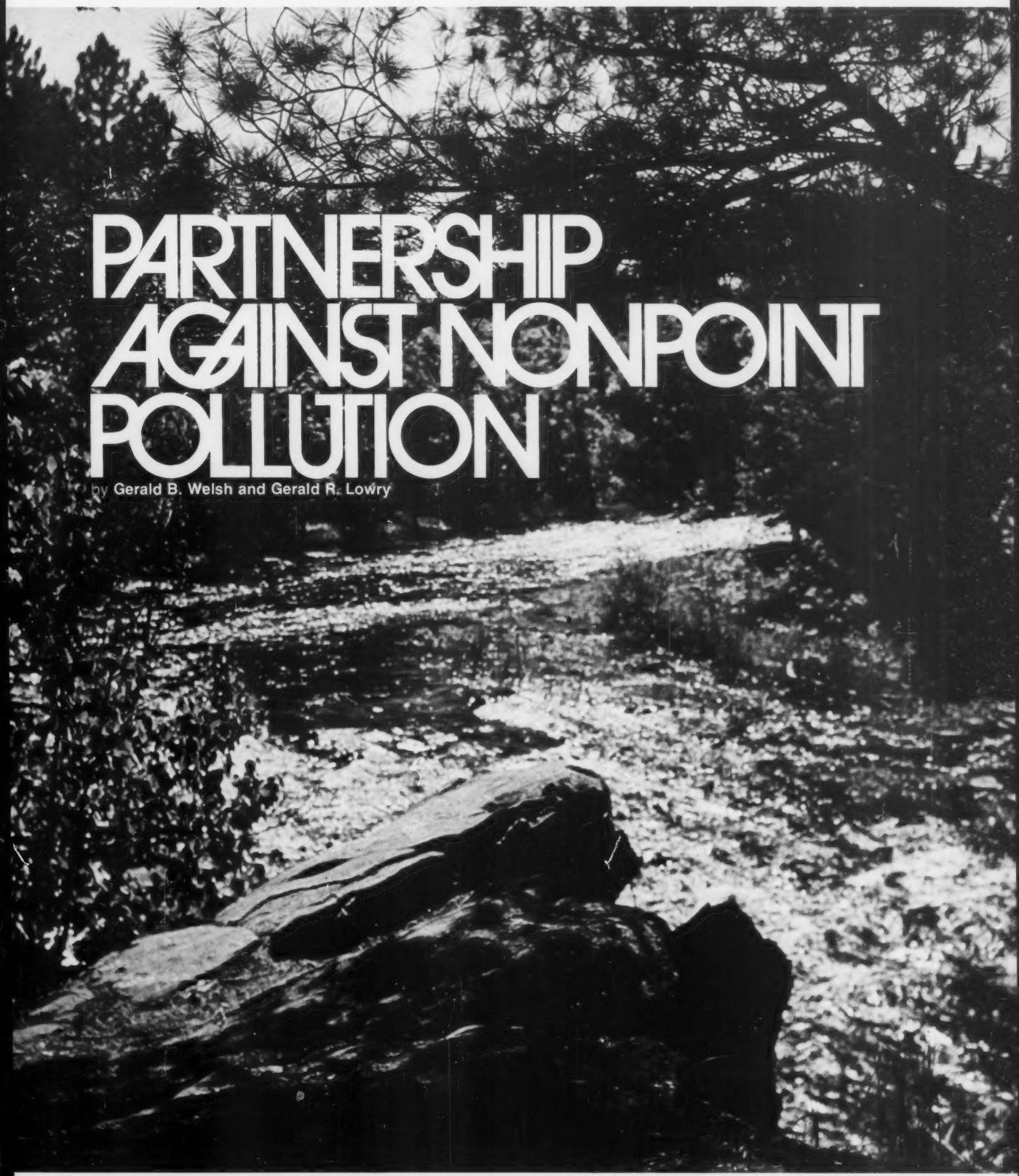
Perhaps this sense of urgency and a willingness to face cold, unpleasant realities made it easier for the agencies and citizens involved to put aside petty differences and personal interests and work toward the best common solution for all interests.

There were many questions: How does one weigh economic and recreational needs against water supply? What about the legality of transferring water from one river basin to another? If growth must stop, who decides where? If a reregulation dam is recommended in the final plan, who will build it? What kind of State or local efforts are needed to implement the needed water resources plans? What decisions should be made about power trade-offs?

Many of these questions have been answered only because a group of dedicated people who had never before worked together sat down and figured out *why* they should and *how* they could.

At one time or another, nearly everybody learned he was wrong about something; but he could admit it gracefully and get on with the process of discovering what was right, not only for him but for all the others. There were tradeoffs and compromises and times, in both public and private meetings, when tempers flared and selfishness showed. Despite all of the obstacles to be overcome, an effective study evolved and a group of people learned they could work together for the benefit of a complex metropolitan region. ■

The Savannah District recently proposed a similar partnership for managing the newly initiated Savannah Urban Study with EPA, Georgia's EPD and local governments. A memorandum of understanding was being executed at the time this issue went to press.



PARTNERSHIP AGAINST NONPOINT POLLUTION

by Gerald B. Welsh and Gerald R. Lowry

It is nearly 5 years since passage of Public Law 92-500—the Federal Water Pollution Control Act Amendments of 1972. In most respects, the law's objective, "to restore and maintain the chemical, physical and biological integrity of the Nation's waters," remains a distant goal rather than a reality. Many have grave doubts that the 1983 deadline for several of the objectives can be met.

In one important area, however, the mechanism for controlling water pollution is already in place and the expertise is available. That area is the control of pollution from so-called nonpoint sources required by Section 208 of the 1972 Amendments.

Point source pollution is easier to understand than nonpoint. It isn't hard to visualize raw effluent or poisonous chemicals flowing from pipes into our lakes and rivers. Many Americans have seen them firsthand. Nonpoint source pollution, on the other hand, is the result of storm water moving over thousands or even millions of acres at a time, washing particles of soil downhill into creeks, rivers or lakes.

The authors are employed by the Soil Conservation Service, U.S. Department of Agriculture, in Washington, D.C. Mr. Welsh, of the Resource Planning Branch, is also chairman of the USDA Section 208 Work Group. Mr. Lowry is acting director of the Environmental Services Division.

Sediment—Major Water Pollutant

The impact of nonpoint pollutants on water quality is substantial. Soil erosion and sedimentation are major problems nationwide. By volume, sediment is the Nation's greatest single water pollutant—point or nonpoint. Several billion tons of soil erode annually and much of this is deposited as sediment in lakes and waterways.

Sediment particles can carry such chemicals as phosphates and pesticides. Runoff from farmland may wash pesticides into lakes and streams in amounts sufficient to poison fish. Nitrates and phosphates from fertilizers also may wash off land into streams and lakes, stimulating algae growth and creating other undesirable effects. Animal wastes left on the ground may become a nonpoint water pollutant as well, contaminating surface and groundwater and creating a greater menace in some areas than human sewage.

Sediment bars, washed from land cleared for construction that was not seeded to prevent erosion, pile up in a stream near Ashland, Wisconsin. Sediment is the major cause of non-point pollution.

Some of these pollutants become linked with the soil after they are applied to farmlands; and, when soil erosion is stopped, their movement into waterways is halted as well.

Controlling nonpoint sources of pollution is not new to America's farmers, ranchers and foresters. They are aware that soil erosion is a cause of nonpoint pollution and have been working for decades to control the problem.

The Soil Conservation Service (SCS) is a component of the U.S. Department of Agriculture (USDA). Formed in 1935, the Service is dedicated to the conservation, development and productive use of our soil and water resources and has assisted them in this work. For more than 40 years, SCS professionals have worked with land users in local conservation districts throughout the Nation to protect our soil and water base.

It is this combination of forces—America's farmers, the Soil Conservation Service and local conservation districts together with the various Section 208 planning agencies—that can provide a solution to the problem of nonpoint pollution. As Section 208 of P.L. 92-500 is implemented, promising new approaches to achieving soil conservation are expected to emerge.

A Grass Roots Approach

The Service has more than 13,000 employees based at approximately 3,600 SCS field offices nationwide who help land users apply soil and water conservation practices. SCS specialists include soil conservationists, soil scientists, engineers, agronomists, range conservationists, biologists, economists and foresters.

SCS works through conservation districts that are legal subdivisions of State government responsible under State law for conservation work within their districts. There are 2,950 conservation districts in the U.S. Most cover one or more counties and are directed by an elected or appointed unsalaried board of local citizens.

Through agreements with the districts, SCS provides the services of professional men and women who help districts plan and carry out a wide range of soil and water conservation programs. Other USDA agencies, such as the Forest Service, also provide assistance. Districts channel the services of professional conservationists to individual farmers, ranchers and other land users as well as to groups and units of government who need SCS help. The person or group who receives assistance in planning and carrying out soil and water conservation work through the districts is called a "cooperator." SCS and the districts are helping more than two million cooperators nationwide—a remarkable record for a voluntary program.

The ongoing, grass roots program of conservation planning and application of conservation practices by farmers and other land users with the help of SCS professionals and conservation districts is one of the Nation's best available means for controlling nonpoint sources of pollution.

Readymade Potential

Traditionally SCS, the conservation districts and other cooperating agencies have worked primarily in the broad field of natural resource conservation rather than specifically on water pollution control. Water quality agencies, on the other hand, have concentrated primarily on pollution control,

Eroded soil from stormwater moving across thousands of unprotected acres is deposited in rivers and lakes as sediment. Susceptible soils can wash away in North Dakota fields as well as along the red clay shores of Lake Superior. The cost is enormous, in topsoil lost and in lowered water quality.

and mainly on pollution from municipal and industrial sources.

There has been insufficient communication over the years between soil conservation and water quality agencies, and a lack of understanding of each other's problems and potential contributions. Local conservation districts, backed by SCS field offices, had readymade potential to assist in developing and implementing 208 nonpoint water quality management plans immediately when PL-92-500 was passed in 1972. Yet for several years following the law's enactment, most of the various agencies designed to develop water quality management plans focused their energies almost exclusively on point source pollution control.

This is understandable. Previous water quality legislation had dealt almost exclusively with point source pollution, as had state inspection procedures. Therefore, professional water quality planners continued to concentrate on municipal and industrial problems.

Now the focus is changing. More and more 208 planners are aware of the existence of soil and water conservation districts. They also know that the districts, in concert with SCS conservationists and other USDA professionals, can give them invaluable immediate and long-range help in formulating nonpoint pollution control plans. A variety of other

Contour stripcropping is one way of controlling erosion and the resulting non-point pollution.

Federal, State and local groups also work with districts and can provide help.

With this new awareness, we see an emerging partnership between conservation districts, the U.S. Environmental Protection Agency (EPA), SCS and other USDA agencies, and State and areawide water quality agencies. We believe that this partnership can formulate the dominant strategy for effective nonpoint pollution control in rural America in the decades ahead.

The ultimate success of this partnership and the resulting water quality management will depend in large measure on the continued strengthening of communication, cooperation and understanding between the various water quality groups.

SCS is taking steps to reinforce this partnership. There are 39 SCS professionals now assigned to various state and areawide 208 agencies. The Service also has professional conservationists assigned to EPA in Washington, D.C., and to EPA regional offices in Philadelphia, Dallas, Kansas City, Denver, Seattle and Atlanta.[1] In fiscal year 1976, SCS contributed 42 man-years to help 208 planners, and SCS state conservationists expect the Service to contribute 154 man-years to 208 planning in 1977. It bears mentioning that no 208 monies have come directly to SCS for this purpose.

Cooperation on EPA Demonstration Projects

The U.S. Environmental Protection Agency is funding three demonstration projects under Section 108[2] of Public Law 92-500. All are coming up with new methods and techniques for eliminating or controlling pollution in watersheds of the Great Lakes. The prime contractor in each project is a local soil and water conservation district.

The Black Creek Project, in Indiana, is reducing the amount of sediment and other agricultural pollutants such as pesticides that move into the Maumee River and eventually into Lake Erie. Approaches to promote the project range from minimum tillage to a study of farmer attitudes towards conservation. The prime contractor is the Allen County Soil and Water Conservation District, aided by Purdue University, SCS and other agencies.

The Red Clay Project, covering five counties in Minnesota and Wisconsin, is aimed at reducing soil erosion to keep the hard-to-manage, local red clay soil out of Lake Superior. The red clay is a shrink-swell soil that fractures easily when disturbed and then moves into streams and rivers. Once in the water, it remains suspended for long periods. For as much as several hundred yards into Lake Superior the water is colored bright red by its sediment.

The prime contractor for the Red Clay Project is the Douglas County, Wisconsin Soil and Water Conservation District. Four other conservation districts also are involved, along with the Wisconsin Department of Natural Resources, the Minnesota Pollution Control Agency and other agencies. Demonstrators are trying "everything in the book," from hydroseeding to paving with bricks, to keep the soil from breaking up and getting into waterways. Cost-sharing is used

[1] Since the writing of this article, an SCS professional conservationist has been assigned to the EPA regional office in New York City.

[2] Section 108 of P.L. 92-500 pertains specifically to the watersheds of the Great Lakes.

to induce local farmers to keep cattle from disturbing streambanks and to develop alternate sources of water for livestock.

The Washington County Project, near Milwaukee, is showing local people ways to keep sediment washed from urbanizing areas out of Lake Michigan. The Washington County Soil and Water Conservation District is the prime contractor, assisted by the Southeast Wisconsin Regional Planning Commission, the Wisconsin Department of Natural Resources, and other agencies. Tours, brochures, and new institutional arrangements are used to secure the local involvement and participation needed to make a success of the program.

These projects got under way about 3 years ago and should conclude within the next year or two. The experience gained should be useful in 208 planning throughout the Great Lakes Region.

Cooperation is growing in other ways. EPA has given the National Association of Conservation Districts a grant to foster even closer relationships between conservation districts and water quality officials as they develop their water quality management plans.

The recent publication, "Conservation Districts and 208 Water Quality Management," was financed by this grant. It details potential conservation district involvement in the preparation and implementation of State and areawide water quality management plans. The pamphlet reviews nonpoint source identification and assessment, selection of "Best Management Practices," and management agencies and regulatory programs. EPA has printed 10,000 copies of this publication and sent them to EPA regional offices, State and areawide 208 agencies, SCS field offices, and all conservation district offices.

Range seeding prevents excessive soil and water loss, produces forage and improves the natural beauty of grazing land.

"No-till" farming, in which a new crop is planted through the residue of an old crop killed by herbicides, reduces soil erosion to practically zero.

Gus Dornbusch, former SCS State Conservation Engineer in Georgia, is now on 208 assignment at EPA's Region IV in Atlanta. His EPA colleague is James Crooks, hydrologist and nonpoint source specialist. The two-man team covers an eight-State region: Alabama, Mississippi, Georgia, Florida, North Carolina, South Carolina, Tennessee and Kentucky. In the past 4 months, they have visited seven of these States and met with water quality agencies designated by governors to develop the various State and areawide water quality management plans.

"Our most important task," Dornbusch explains, "has been to show the agencies that the mechanism for 208 nonpoint pollution control planning and implementation is already in place. It exists in successful, ongoing soil and water conservation programs throughout the United States. The help we need is available right now from conservation districts, the Soil Conservation Service, Extension Service, Agricultural Stabilization and Conservation Service, Forest Service and others. Another important part of the apparatus is to be found among the many State and county pollution control and environmental conservation groups."

Dornbusch stresses the importance of keeping the 208 Water Quality Program simple. By this he means that scrupulous care must be taken to avoid costly gathering of information and data that is not necessary.

"What good can come from compiling an immense amount of expensive data in a 3-inch volume and then ignoring it?" he asks. "If we recognize that the means to accomplish our work are already at hand, we will be able to plan efficiently, then more quickly direct our energies to applying needed water quality conservation measures on the land."

Challenge to Districts

Bob Hibbard, president of the New Hampshire Association of Conservation Districts, agrees that the 208 Program must

The proper treatment of pastureland prolongs the life of desirable forage species and maintains forage quality, reducing erosion from water.

be kept simple. Hibbard farms 1,500 acres—a livestock and forest products operation—in the central New Hampshire town of Loudon. He is supervisor of New Hampshire's Merrimack County Conservation District and has been a district cooperator for 25 years.

"Nonpoint source pollution control offers a real opportunity to conservation districts," Hibbard says. "The problems being studied are to a large extent the problems which districts have been working on so successfully for the past 30 years."

According to this New Hampshire farmer, the chief difference between the present effort to control nonpoint source pollution and the traditional work of the conservation districts lies in the scope of the attack.

"Districts have struggled along for years solving the problems with meager funds, contributions of time and effort, and, through necessity, a well-developed ability to scrounge help from a number of sources—especially the voluntary cooperation of landowners on the basis of enlightened self-interest.

"Now," he continues, "with hundreds of millions of dollars allocated to the study and control of nonpoint pollution, it is evident that the problems involved are those with which districts are most familiar: erosion, sedimentation, uncontrolled runoff, inadequate stormwater management and septic system failures. And as districts have demonstrated, their solution is found in most of the old conservation standbys; conservation practices that districts have promoted for years—stripcropping, grassed waterways, contour plowing, no-till cultivation, close-growing vegetation on steep slopes and the like."

Hibbard points out that the change in scope lies in the number of people who have to be reached to make the necessary changes in land use management within the time allotted. "Where districts have worked primarily with farmers, the increased scale of the problem will bring in many others—suburbanites and city people, loggers, builders, developers and engineers."

Hibbard adds that it may be necessary to use new methods to convince people of the need to adopt soil and water conservation practices for water pollution control. "Districts have relied on the voluntary cooperation of land users, with the incentive of technical assistance and very limited cost-sharing, to get the conservation job done. Hopefully it can still be carried out on this basis. Certainly districts would seem to be the natural source to go to for an inventory of the problems and guidance concerning needed methods of control."

Determining Best Management Practices

EPA Administrator Douglas M. Costle has emphasized the dual importance of voluntary programs and "Best Management Practices" in achieving 208 nonpoint source pollution goals.

In a recent speech Costle said: "Let me emphasize the fact that nonpoint source problems are widespread, and we don't expect all such sources to be cleaned up quickly or completely. But we intend to move ahead with this program without delay, employing the whole range of pollution control tools, including education, regulation, improved management, incentives and voluntary programs. I want to emphasize the word 'voluntary,' because to achieve our goals in this area, a voluntary program is going to be a key ingredient to success. I feel confident that enforcement will be needed and used only in rare circumstances."

Joseph Krivak, Chief of EPA's Nonpoint Sources Branch, has stated: "The keystone of our nonpoint source strategy is the concept of 'Best Management Practices.' "

And what are "Best Management Practices?" The term has been so casually used that it deserves careful explanation.

Many soil and water conservation practices, singly or in combination, help keep water where it falls and soil, plant residues and animal wastes in place. When this is done, sediment, many nutrients and pesticides are kept from reaching our surface waters. In its simplest terms, this is nonpoint source pollution control.

Soil and water conservation practices that keep pollutants out of surface waters, and livestock waste management practices that have a similar effect, are "Best Management Practices." Every SCS field office has a technical guide that explains specific conservation practices tailored to local soil, climate, and land users. These practices can control pollution caused by erosion and sedimentation.

However, SCS does not have "Best Management Practices" for controlling all sources of nonpoint pollution. For example, in many urban areas street litter, oils and heavy metals on roads and the like are significant nonpoint sources of pollution. SCS does not have practices that would reduce pollution from these sources. Nor does SCS have practices to control pollution from road salt, acid mine drainage and similar nonpoint sources.

Massive Undertaking

The question remains: will each State, as required by Section 208 of PL 92-500, be able to provide the Environmental Protection Agency by November 1, 1978, with an implementable plan for abating water pollution from all identifiable sources, including such nonpoint sources as farmland, urbanizing land and other disturbed areas? The way is clear. The means are at hand.

We realize, however, that the work is and will continue to be a major undertaking. For there is no quick cure-all for nonpoint source water pollution.

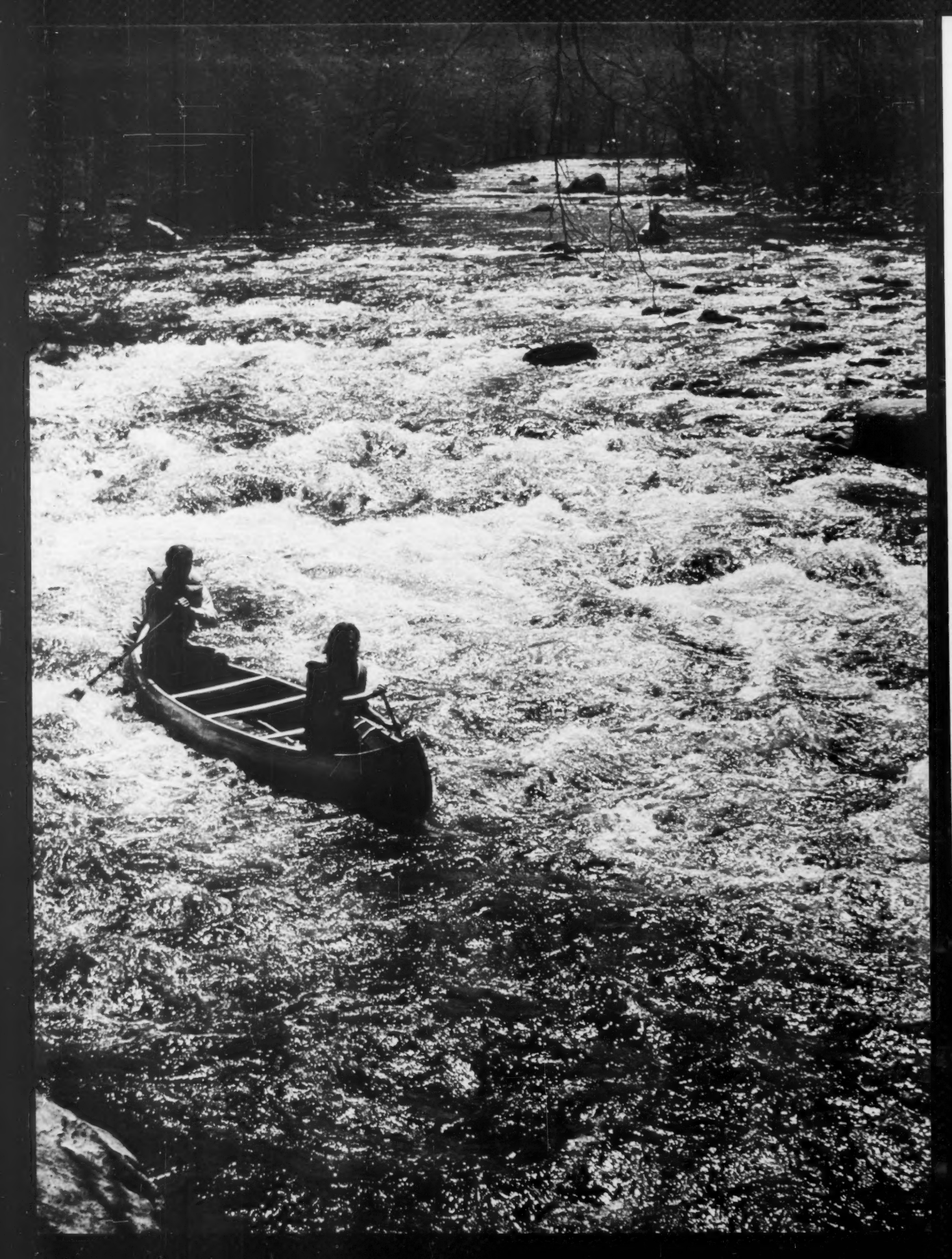
The scale of erosion and sedimentation is massive.

Consider this fact: there are some 100,000 kinds of soil in the United States, each with unique characteristics and potentials and a variety of uses. Fifty years ago, Hugh Hammond Bennett, the father of soil conservation and the first administrator of the Soil Conservation Service, succinctly defined the requirements of effective soil and water conservation. "Conservation is possible," Bennett stressed, "only if we use every acre according to its capability, and treat every acre according to its need."

"You can't farm a flat Indiana field like you would a rolling Georgia slope," Bennett said, "or a Vermont mountainside like a Texas river bottom. It is that simple and that complex."

Fifty years ago, these ideas were revolutionary. Today, they are fundamental to soil and water conservation and the key to nonpoint source pollution control. The Nation's success with 208 water quality management will be no greater than the people's understanding of these truths. ■

There are some 100,000 kinds of soil in the United States, each with its own uses and limitations. Vermont's steep hills, for instance, are treated differently from Georgia tobaccoland.



In Lieu Of Dams

by **Brent Blackwelder**

The best way to dispel the suspicion that conservationists want to return the country to the Stone Age by opposing water resource development projects is to consider some of the superb alternatives we have proposed to traditional dam building, canal digging and stream channelization. Water resource projects are designed primarily to achieve one or more of the following objectives: flood control, water supply, recreation, hydropower and navigation. Given the desirability of providing these objectives, if the environmental community wants the Army Corps of Engineers and other agencies to stop altering the rivers and streams of America through water resource construction, what do we have to offer instead?

The alternatives I wish to discuss are nonstructural solutions to flood problems; water pricing, water conservation and proper management for meeting water supply needs; development of scenic rivers or non-water based recreation instead of flat-water reservoir recreation; energy conservation measures taken prior to building more hydropower dams; and finally, refurbishing our country's railroads instead of constructing new barge canals.

Flood Control

A wide range of nonstructural options is available to replace structural alterations of rivers and streams in achieving flood control. The term "nonstructural" means that these alternatives do not involve alterations of rivers through damming or channelizing.

The alternative of creating a greenbelt of park land along a stream is very attractive in some areas where stream channelization has been proposed for flood control. The basic idea is that many uses of flood plain lands are compatible with periodic flooding. Devoting a green strip of park land alongside both banks of a river, serves the objective of flood control without destroying the natural beauty of the rivers or its recreational potential.

Dr. Blackwelder is the Washington representative of the Environmental Policy Center. This organization, formed in 1972, is a public interest, environmental lobby working in the fields of energy and water resources.

The Corps of Engineers is currently applying two such green belt concepts at its Indian Bend Wash project in Arizona and along the South Platte River in Colorado, where the Corps has transferred funds intended for channelization to a green belt project. That the designing of such nonstructural projects can pose an engineering challenge is demonstrated by the fact that the Indian Bend Wash project received a distinguished engineering award from the American Society of Civil Engineers.

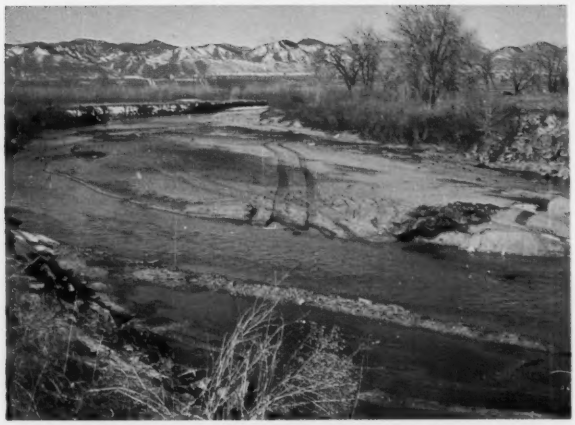
In Prairie du Chien, Wisconsin the Corps is using two other nonstructural techniques to achieve flood control. It is relocating some residents from an island in the flood plain and is also flood proofing other buildings in the vulnerable area. By combining flood proofing and partial evacuation of the flood plain, the Corps has produced a workable plan where the traditional approaches of changing the river were too costly.

The Charles River Natural Storage Area in Massachusetts offers an example of still another nonstructural flood control technique. Here the Corps of Engineers wants to preserve 17 upstream valleys in their natural condition to prevent an increase in flood damages downstream which could occur if these valleys and their associated wetlands were developed. In 1971 the Corps found that flood losses averaged $158,000 annually. If 40 percent of the upstream wetlands storage areas were developed, however, annual flood damages would jump to a staggering $957,000.

These four nonstructural flood control projects show that the Corps can and will carry out such plans. The problem is that nonstructural projects are the exception, not the rule, as far as flood control is concerned. Despite the provision of section 73 of the Water Resources Development Act of 1974 (it provided authority for Federal agencies to pursue nonstructural alternatives with cost-sharing provisions), progress in starting a large number of nonstructural projects has been very slow. This is especially regrettable since nonstructural projects do not have environmentally damaging impacts and, in the judgment of many, offer the best hope of achieving a reduction in the ever mounting annual flood damages billed to our country.

The trouble is that despite increasing expenditures on flood control structures, and despite the damages such structures

The Corps of Engineers abandoned plans for the Salem Church Dam on the Rappahannock River and recommended instead protection of the river through a scenic river designation.



Along the South Platte River near Denver, a river bank park has been chosen instead of a concrete channelization project to solve flooding problems.

have prevented, the country's annual flood damage bill continues to rise. Both the Task Force on Federal Flood Control Policy and the National Water Commission strongly support greater reliance on flood plain management techniques as the way to solve the Nation's Nation's flood problems.

Continued paving over of land in metropolitan areas leads to greater runoff and causes periodic flooding of streams. A wide range of tools is available to curtail some of this destructive runoff from suburban shopping centers and parking lots. On-site detention ponds should be required for large-scale developments. Gravel dry wells or recharge pits and porous surfacing material can help solve runoff problems. Controlling erosion by planting ground cover in new housing developments and shopping centers can also curb runoff and prevent siltation and the resultant loss of channel capacity in urban creeks and streams.

One important feature of nonstructural alternatives like flood plain evacuation and flood proofing is that they remove the burden of flood control from individuals not responsible for the problem—those inhabiting the upstream area. A disadvantage of reservoirs from the standpoint of social equity is that farmers and rural residents who are not the cause of the flood problem are forced to give up their land, some of which has been in the same family for generations, for a dam to protect people who have built downstream in the flood plain.

Recreation

Most conservationists generally feel that enough reservoirs have been built to last far into the next century. In fact, the Corps should not, we argue, continue to cite recreation benefits to justify reservoir projects because demand for other forms of recreation, including non-water activities, is growing much faster than flat-water recreation demands. Second, building lakes in the rural countryside neglects the pressing recreation needs of the inner city where there is an insufficient number of facilities for regular use on a daily basis. Third, reservoirs eliminate some truly unique areas which provide unsurpassed recreational opportunities.

The Meramec Park Dam in Missouri is a good example of a project which will eliminate more recreational opportunities than it provides.

Conservationists discovered that about half of the claimed recreation benefits were coming from "sightseeing"—people coming to the reservoir not to boat, fish, picnic or swim but simply to stare at what the Corps had constructed.

Furthermore, the area already has an abundance of recreational opportunities: fishing and boating on the Meramec River; camping, hiking and picnicking in a State park; a wildlife management area; and, in addition, spelunking in numerous caves, including the beautiful Onondaga. Each year several hundred thousand people visit Onondaga Cave, a truly unique asset to the area and Nation.

The alternative to the Meramec Park Dam would involve establishing a green belt and recreation area in the lower Meramec River and a combination of farm land, wildlife management areas and park land in the upstream reaches.

The point of this example is that the Corps partially justifies some projects by using recreational benefits when there are ample recreational opportunities already in the project area. Given hundreds of large reservoirs now existing all over the country and the growing demands for other types of recreation, it is a serious mistake to irrevocably commit these scarce river valley resources. We essentially deprive future generations of some choice in these matters and, at the same time, neglect the plight of the inner city resident who must face crowded facilities if he chooses to picnic, swim or play tennis. The obvious alternative to more reservoirs is to spend money on inner city recreation facilities and to leave the rural landscape available for other forms of enjoyment.

Only 19 rivers are now included in the national wild and scenic rivers system, but over 50,000 public and private dams have been built. It is time to correct the imbalance, and conservationists propose increasing the national wild and scenic river system by several hundred rivers to preserve both their natural and recreational value.

Water Supply

A wide range of methods dealing with water supply problems can be tried before building more reservoirs. In a number of cases where reservoirs have been proposed to solve water

supply problems, conservationists have found that a water shortage did not exist, that the demand was based on questionable population projections or that benefits would accrue to only a handful of beneficiaries. For instance, we discovered that 70 percent of the water supply benefits of one Corps project, Lukfata Dam, would go to a single catfish farm operation and that the small town of Idabell, Oklahoma, population 6,000, would have to grow to 100,000 over the 50-year life of the project to fully use the projected water supply.

Setting aside such examples, let us suppose that we encounter an area with a legitimate water supply problem. What are the alternatives to building reservoirs? One of the most overlooked choices, particularly east of the Mississippi, is the use of groundwater supplies. The National Waterwell Association argues that groundwater reserves are frequently available on a sustained yield basis for as little as one tenth the cost of surface supplies. In the case of the controversial Oakley Reservoir in Illinois, which the Corps has now placed in the inactive category, a proper examination of the ample groundwater supply was not carried out.

Springs and caves, such as these along Virginia's Cedar Creek, are some of the unique features along rivers that are lost as the result of construction of some dams.

Wisconsin's Namekagon River offers opportunities for canoeists who wish to avoid white water. There are 50,000 dams in the country but only 19 rivers in the National Wild and Scenic River System.

The Allenspur Dam, proposed by the Bureau of Reclamation, would drown this magnificent stretch of the Yellowstone River which conservationists want protected as part of a State or National scenic rivers system.

More emphasis should be placed on the supply side of the equation. The National Water Commission, established by Congress in 1968 to do a 5-year in-depth study of all the Nation's water problems, devoted an entire chapter to better use of existing supplies in its final report.

Water Policies for the Future

The Commission found little incentive for proper use of water because most cities assess a flat charge for the first units of water consumed and then assess progressively lower charges per unit as more water is consumed. The inevitable result is that there is little incentive to avoid excessive use.

According to the Commission, for instance, plumbing fixtures for showers and toilets could reduce total water use in the average household by as much as 35 percent and save commercial and business establishments up to 50 percent.

Conservationists criticize some reservoir construction because the fluctuating water levels kill vegetation around the reservoir and can create severe erosion problems. Shown here is Shelbyville Reservoir, Ill., where substantial erosion problems have occurred.

The Commission notes that ". . . if the common pricing policy were reversed there would be a financial penalty for excessive consumption and an incentive for individual conservation. Efficiency would also be improved by pricing policies which charged more at times of peak demand and less at times of slack demand."

To compound the problem, some areas like New York City do not meter their water, nor have they repaired leaks or fixed defective connections and valves. The Commission recommends effective leak control programs, installation of water metering, reform in the pricing structure for water and amendments to plumbing codes requiring the installation of water saving fixtures and appliances. By requiring localities to take these steps prior to receiving any Federal planning money for a water supply reservior, the Federal Government could easily eliminate much unneeded dam building.

Proper management of already existing reservoirs can go a long way to alleviate the problems of water supply. Dr. Daniel Sheer, planning engineer for the Interstate Commission on the Potomac River Basin, has argued cogently that the Washington metropolitan area already has a sufficient number of reservoirs which, if properly managed, could meet the area's water needs well into the next century.

Dr. Sheer's proposal would require keeping tributary reservoirs full by using the adequate water flow from the Potomac River before a drought ever starts. By this method, Dr. Sheer points out, ". . . the Washington area would come through the worst drought with . . . 5 billion gallons of water to spare . . ." *

These alternatives to water supply reservoirs do not exhaust the possibilities. In the West, reform of groundwater management codes and the "use-it-or-lose-it" doctrine are

* Daniel P. Sheer, "Perspective on the Washington Metropolitan Area Water Supply Problem, 1977. Available from the Interstate Commission on the Potomac River Basin.

River valleys contain important scientific, educational and historic sites which can be destroyed through water resource development projects. Rustic mills like this one in Missouri's Ozarks along the White River are becoming scarce.

Environmentalists recommend full development of energy conservation alternatives prior to construction of gigantic new hydropower dams such as the Devil's Canyon Dam being planned in this unspoiled portion of Alaska's Susitna River Basin.

essential. Land treatment techniques for sewage disposal and recycling of wastewater, some of which have been pioneered by the Corps, yield good quantities of pure water.

Navigation

In looking to alternatives to navigation projects, we must define the ultimate goal of public spending for transportation. A reasonable goal would be achieving national transportation efficiency. This would benefit the entire economy—the businessman, the consumer and the environment. Conservationists argue that present navigation policy, which includes canal building, does not contribute to this goal. On the contrary, we are convinced that new canals damage the environment, are inefficient and are not justified economically.

The basic alternative to navigation projects lies in increased and improved railroad service and efficiency. From the environmental standpoint railroads are desirable because canals are generally much more destructive than railroad corridors. Furthermore, all the major railroad corridors have already been built so whatever environmental damage these routes have caused is a *fait accompli*.

In the area of energy efficiency the University of Illinois Center for Advanced Computation looked into prior studies of the fuel efficiencies of barge and rail modes. The Center found that studies which showed an energy advantage to barges had relied on mere ton/mile comparisons of energy consumption and had used average rail data for the entire country. These earlier studies neglected the fact that barges follow meandering rivers, thus traveling more miles to reach a given point than trains. Also, barges and railroads both ship bulk commodities which, if moved in unit trains, help give a slight energy advantage to railroads.

Is placing greater reliance on the railroads a viable alternative? Clearly, such a decision would have environmental advantages and no obvious energy disadvantages. It is a

A Cost/Benefit Comparison Based on the Dickey-Lincoln Hydro-Power Proposal

by Dr. James MacKenzie, Scientific Staff
Massachusetts Audubon Society
April 1977

	Cost	Energy Produced	Energy Saved
Dickey-Lincoln (1976)	$668 million	1.2 billion kw hrs = 4.1 trillion BTU per year	none
Conservation Alternatives			
Attic Insulation (9" fiberglass, contractor installed @ .30/sq. ft.)	$668 million	none	177 trillion BTU per year 43 times as much as Dickey-Lincoln
Wall Insulation (Foam installed @ .70/sq. ft.)	$668 million	none	31 trillion BTU per year 7.5 times as much as Dickey-Lincoln
Storm Windows ($30 each, installed)	$668 million	none	18 trillion BTU per year more than 4 times Dickey-Lincoln

legitimate choice because there is already more track available than we now use. Professors Findley and Hannon of the University of Illinois proposed giving the Corps of Engineers authority to repair the Nation's rail beds to increase use of railroads. In an article published in *National Resources Journal,* they cite the railroads' generally poor record of track maintenance and note that the Corps is experienced in the area of rail repair. Ironically, the Corps has built over 1,500 miles of new rail bed in the past 25 years to replace old rail lines inundated by its reservoirs.

Furthermore, the Federal Government now pays 100 percent of the construction costs cf new canals and all the operation and maintenance costs of the inland waterway system. If the beneficiaries of a number of major new canal projects had to pay for them, then the canals would probably not be built.

According to the Department of Transportation, the Federal Government has put some $30 billion over the past decade into our national transportation network. Until the passage of the Rail Reorganization Act of 1973, railroads had for many decades gone without receiving even a fraction of this support. As a result, our rail network has declined at the very time when it has such obvious advantages over other modes. Conservationists who oppose barge canal projects are thus not being obstructionists without alternatives. Rather we say that revitalization of our railroads is a more sensible way to spend public transportation dollars.

Hydropower

While most Army Corps of Engineers projects do not produce hydropower (only 28 projects of more than 200 scheduled for some type of construction in the fiscal 1977 budget would generate electricity), conservationists do have much better alternatives to the construction of large hydropower dams. At the outset one might wonder why conservationists object to some hydropower projects. Aren't they a "pollution-free" form of energy which draw upon a renewable resource? It is true that hydropower projects do not have many of the environmental problems associated with fossil fuel or nuclear power plants, but they do have major environmental drawbacks: inundation of vast amounts of forest and significant wildlife habitat, damage to the native acquatic life through alteration of historic flow patterns, blocking of migratory fish passages, and damage to coastal resources by cutting off the downstream flow of nutrients.

The best alternative to hydropower projects is putting our major national effort into energy conservation together with the development of such alternatives as solar energy and wind power. One example will demonstrate the dramatic difference in results if we go the energy conservation route. If instead of building Dickey-Lincoln Dam in northern Maine the money were put into insulating attics we would realize the equivalent of 43 times the output of the Dickey-Lincoln project. Investing the money in insulation of walls would yield an equivalent savings of 7.5 times the output of the project. Installation of storm windows would yield 4 times the output. Doesn't it make sense to pursue such alternatives first before making irrevocable commitments of river resources?

The Corps is now being assigned the task of evaluating the potential of installing generators in numerous existing small dams throughout the United States. This alternative appears to have important environmental advantages over the construction of new dams.

Many of the alternatives I have discussed—nonstructural flood control projects for instance—could be undertaken by the Corps without further legislation. Others such as the repair of the Nation's rail beds would require new legislative authority. Some of the alternatives would have to be implemented by other Federal agencies like the Bureau of Outdoor Recreation in the case of scenic rivers or by appropriate State or local entities.

Pursuing conservationists' alternatives affords the best way of achieving the legitimate objectives of water projects—flood control, water supply, energy, recreation and transportation efficiency—while at the same time avoiding environmental damages and the loss of areas of scientific, educational and historic importance. Furthermore, these alternatives do not constitute irreversible commitments of river valleys; they leave open choices to future generations which are precluded by many traditional water development projects. Finally, conservationists' alternatives often have the advantage of being less costly to the taxpayer. ■

Events, Deeds & Deliberations

National Water Assessment

A major contribution to a more complete understanding of the adequacy of the Nation's supplies of water in meeting the country's water requirements is scheduled to be completed by the end of the year. The national water assessment, conducted by the U.S. Water Resources Council, is the first such study since the initial assessment was finished in 1968.

Greater regional and public participation characterize the new study, resulting in a description of water resources with more geographic detail than found in the earlier study. It places major emphasis on the urgency of resolving problems from national and State-regional viewpoints. Through the assessment, the Council aims to better inform the Executive branch, the Congress, the States and the public of problems as well as actions needed to meet water and related land resource requirements in future years. A review draft for Federal agencies is scheduled for completion in September 1977. ■

Wastewater Management Course

A self-study correspondence course for middle managers and personnel in the water and wastewater field is being offered by Michigan State University. The seven-lesson course covers an introduction to management, motivation and problem solving, communication and the delegation of authority, planning and organization, staffing and directing, controlling, and managerial relations with the union and employees. Further information can be obtained from the Self-Study Course Coordinator, c/o Clark E. DeHaven, Director of Executive Programs, 432 Eppley Center, Michigan State University, East Lansing, Michigan 48824. ■

Local Cooperation Wins Award

Local cooperation in turning salvaged log cabins into a model pioneer village in Waynesville, Ohio won an honorable mention in the Contractor category of the Chief of Engineers 1976 Environmental Awards program.

Caeser's Creek Pioneer Village Inc. was formed in 1973 as a nonprofit organization to preserve historic cultural resources excavated within the Caeser's Creek Lake project area.

The Pioneer Village began while the Army Corps of Engineers was building a flood control dam on the Little Miami River near Waynesville. The engineers discovered some handcrafted log homes built by the original Quaker settlers. In an effort to preserve these houses, which were scattered throughout the valley, local groups accepted responsibility for salvaging them and formed the Pioneer Village Association in 1973. The Louisville District leased 17.5 acres to the organization. This tract, near Clarksville Road north of Henpeck (Wellman) is the original site of Levi Lukens House, an 1807 log house possessing both historical and architectural significance. The other log and frame structures located within the Corps project area have been moved or soon will be moved to this tract and will be restored, furnished and preserved in a historically authentic manner.

Most of the work is done in the cooperative spirit of pioneer days with local citizens acting as carpenters and stonemasons. When the village is completed, it will be a working farm which will show crops and farm methods of the early 1800s.

Profits from yearly festivals celebrating pioneer days are used to move and restore the buildings. The awards committee called the Pioneer Village an excellent example of cooperation between contractor, the surrounding community, and the Corps of Engineers working together for the benefit of the general public. ■

The Lukens House, built in 1808, the first historic structure given by the Corps to the village, stands on its original site. Other buildings have or will be relocated nearby. The people examining the building and enjoying the village were there for the Spring festival.

Water Re-Use and the Cities

A newly published book, *Water Re-Use and the Cities*, edited by Roger E. Kasperson and Jeanne X. Kasperson, focuses on the safety aspects of reclaimed wastewater, the economic feasibility of water re-use systems, the public acceptance of reclaimed water and manager acceptance of the systems. Contents include orientation and background; potential obstacles to the diffusion of water re-use systems; and water re-use, innovation and public policy. Several existing systems are examined and suggestions for policy changes to encourage greater acceptability and adoption of the vastly untapped resource are presented. The 252-page, illustrated book can be obtained from the University Press of New England, Box 979, New Hampshire 03755. ■

A Record Setting Year

Preliminary estimates compiled by the Army Corps of Engineers indicate that waterborne cargoes in the United States reached a high of 1,803,000,000 tons last year, a 6.4 percent increase over 1975. The previous high was 1,761,600,000 tons established in 1973.

Last year's record volume of traffic reversed the downward trend which began in 1974 (1,746,800,000 tons) and continued through 1975 (1,695,000,000 tons).

Exports registered the largest gain—15.4 percent, while imports increased by 4.4 percent.

All three categories of domestic commerce showed gains. Inland waterway traffic increased 3.1 percent; tonnages for traffic between ports on the Great Lakes increased 2.9 percent; and coastal traffic gained 0.5 percent.

Final figures for 1976 shipments, together with detailed freight tonnages at individual ports and waterways, will be published in November 1977 by the Corps of Engineers Waterborne Commerce Statistics Center at New Orleans. ■

Detecting Oil Discharges

A sophisticated new sensor system that detects illegal discharges of oil in nearly all types of weather, day or night, has been put into operation by U.S. Coast Guard. The Airborne Oil Surveillance System (AOSS), installed aboard a Coast Guard C-130 aircraft, has four sensors that can spot pollution violators and provide evidence toward their prosecution.

Based at Elizabeth City, North Carolina, the specially equipped aircraft conducts routine oil pollution surveillance patrols up to 50 miles out to sea. The sensors can locate and map spills within a 20-mile swath along the aircraft's path, while an aerial reconnaissance camera and multi-channel line scanner provide clear images of oily discharges and identify suspected violators.

A computer controlled console aboard the aircraft allows the equipment operator to view and interpret the sensor data as it is received and to make immediate enforcement decisions when a violation is detected.

AOSS can also be used to detect major sources of ship-generated pollution and assist in fisheries surveillance as well as search and rescue and ice patrol operations off the coast. ■

Hydrology and Conservation

A new guidebook that discusses various aspects of forest hydrology and other upstream hydrology questions related to conservation is now on the market. The techniques it describes include runoff estimation; torrent control; infiltration estimation; snow surveys for water in the mountains; evaluation of mountain land degradation; recycling of wastewater in forests; stream water quality evaluations; transpiration; and surveys of sedimentation in reservoirs. The illustrated conservation guide also includes data on a range layout for a typical reservoir and examples of subdividing soil groups according to land use. The 134-page volume, entitled *Hydrological Techniques for Upstream Conservation,* can be obtained from Unipub, Box 433, Murray Hill Station, New York, New York 10016. ■

Diamond Jubilee

The Board of Engineers for Rivers and Harbors recently completed three-quarters of a century as the agency of independent review of water resources projects for the Chief of the Army Corps of Engineers. The board is unique within the Federal establishment in that the seven members who are senior officers of the Corps, provide an objective, critical review of proposed projects. The members are supported by a professional staff of 66 that includes engineers, environmental economists and transportation specialists.

The board reviews prospective projects which have passed through the gauntlet of Congressional, district and division studies. It passes its recommendations on to the Chief of Engineers and upward through the Secretary of the Army, Office of Management and Budget and finally to Congress for consideration.

Of more than 8,000 project reports reviewed by the board since its inception in 1907, less than 45 percent have been recommended.

The board also published information about coastal ports in the United States and conducts an 11-month training program for Corps planners.

Coinciding with the anniversary was the selection of Colonel Albert C. Costanzo as the resident member of the Board of Engineers for Rivers and Harbors. Colonel Costanzo, previously the Deputy Assistant to the Chief of Engineers, replaces Colonel Robert L. Bangert who retired. ■

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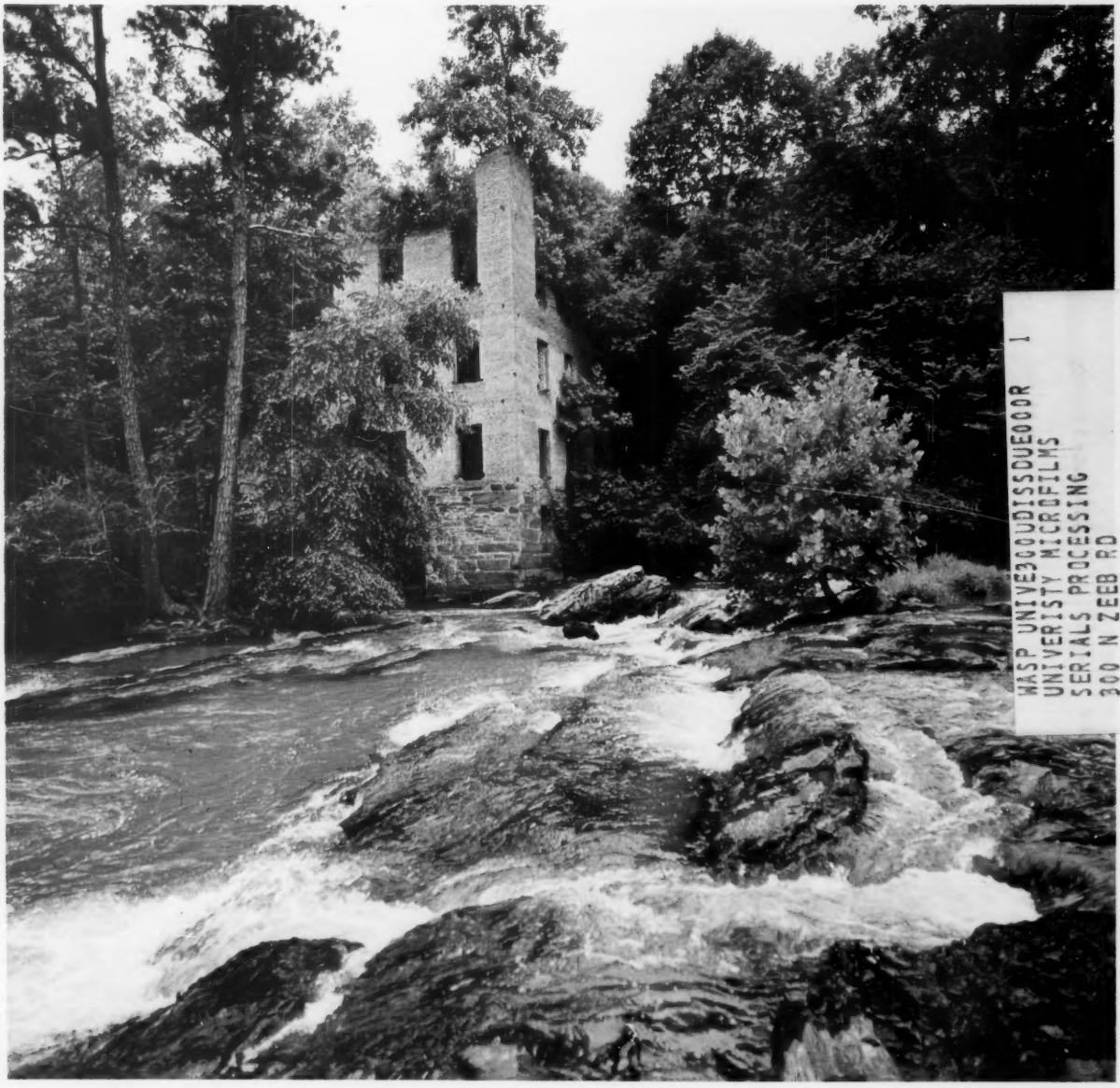

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